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Copy Editor: Katharine Davies
Editor Emeritus: Andrew Sanchez

ART
Art Editor: Fraser McDermott
Photography: Phil Barker, Olly Curtis, Neil Godwin

Cover Photo Credits: Future plc, Nextcloud, Tarsier Studios

BUSINESS
US Marketing & Strategic Partnerships: Stacy Gaines, stacy.gaines@futurenet.com
US Chief Revenue Officer: Luke Edson, luke.edson@futurenet.com
East Coast Account Director: Brandie Rushing, brandie.rushing@futurenet.com
East Coast Account Director: Michael Plump, michael.plump@futurenet.com
East Coast Account Director: Victoria Sanders, victoria.sanders@futurenet.com
East Coast Account Director: Melissa Planty, melissa.planty@futurenet.com
East Coast Account Director: Elizabeth Fleischman, elizabeth.fleischman@futurenet.com
West Coast Account Director: Austin Park, austin.park@futurenet.com
West Coast Account Director: Jack McAuliffe, jack.mcauliffe@futurenet.com
Director, Client Services: Tracy Lam, tracy.lam@futurenet.com

PRODUCTION
Head of Production: Mark Constance
Production Manager: Vivienne Calvert
Project Manager: Clare Scott
Production Assistant: Emily Wood

FUTURE US, INC.
11 West 42nd Street, 15th Floor, New York, NY 10036, USA
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Alan
Dexter

THE BEST THINGS IN LIFE ARE FREE

ACCORDING TO POPULAR CULTURE, that headline is spot on, at least. While we don't always adhere to the idea, we can see that there are moments when free is your best option: If you're looking at doing something as a one-off, you don't want to drop a big bag of cash on a product you're not going to use a lot, so free definitely makes sense.

A quick look at the top-selling apps shows that the biggest sellers are all covered by free alternatives, whether you're talking office software, security, video, image, or audio editing. Some of these free alternatives are just as feature-packed as their big-dollar equivalents. But your time isn't free, so which ones are worth spending it with? This is where we come in, with our cover feature looking at the best free software—turn to page 24 to discover our recommendations.

One area we don't touch on in the feature is gaming, but there are plenty of ways of getting your game on for free if you're prepared to jump through a few hoops. The easiest way of getting a good supply of modern games is by installing the Epic Games app, which gives you a free game or two every week—we're talking quality titles as well, such as *Subnautica, The Witness,* and *Inside.*

If you've signed up for Amazon Prime, it's worth grabbing the Twitch App (www.twitch.tv), as a growing selection of games is given away on there as well. These tend to be smaller, indie games or older classics, but anyone looking for an occasional bit of entertainment is more than catered for. On top of that, it's worth keeping an eye on the likes of GOG and Humble Bundle, as they both give away games from time to time. Of course, there's plenty of games that are free to play in the first place—*DOTA 2, Path of Exile, Fortnite,* and *Hearthstone* are all excellent games and cost nothing to get started.

While we're talking about money, you're probably aware of the growing threat of ransomware. Knowing what to do if you're attacked can genuinely save you money, and having a proper regime in place can protect you in other areas as well. This issue, we show you how to protect your data, and cover what tricks purveyors of ransomware undertake to try to get on your system. It's an evolving battlefield, and it pays to keep abreast of what's happening out there.

Another thing that's worth getting the lowdown on is the next iteration of the Wi-Fi standard, Wi-Fi 6. It does some incredible things for businesses, but also brings advantages to normal consumers. Turn to page 43 to find out why upgrading your wireless network could result in serious benefits.

Kicking off our tutorials, we explain how to get up and running with NextCloud, which gives all the benefits of cloud storage, but with the added security that comes from hosting your data on your own hardware. We also show you how to build a 1440p gaming machine that will last years, and you can tweak the build to suit your needs.

I hope you enjoy the issue.

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Ryzen 3000's Slow Cores

Chips are not reaching the expected boost speeds

AMD'S RYZEN 3000 series has been a huge hit. Armed with lots of zippy Zen 2 cores and AMD's competitive pricing, sales have been brisk. Exact figures are hard to come by, especially for the US market; retailers in other regions are more forthcoming. The major German and South Korean vendors put AMD and Intel neck and neck. This has to be taken with a pinch of salt, of course—these companies represent a fraction of the total market. One source worth taking seriously is Mercury Research, which has been producing PC component market reports since 1994. It has AMD's market share of desktop CPUs at 17.1 percent, up 4.8 percent over a year. The 3000 series only launched in July, so we can expect things to swing even more toward AMD over the next year.

All good news for AMD, but an embarrassing fact has emerged: A lot of the chips don't hit their claimed boost speeds. Some sources had as many as 95 percent fail; others had about half falling short, by 100MHz or so. It transpires that the Ryzen 3000's cores aren't all rated at the same speed. In fact, only one core on each chip is guaranteed to hit the advertised boost speed. Previous Ryzen chips, and Intel offerings, could generally hit boost on all cores. The problem is compounded by poor co-operation between Windows Scheduler and AMD's PBO (Precision Boost Overdrive), which must work together to decide what threads go where, and how the cores respond. A bug in the BIOS firmware was robbing chips of 25–50MHz.

Most people wouldn't notice the difference, but tweakers and modders certainly did, and took to the forums to complain in some numbers. After an annoying silence, AMD admitted there was an "issue." In a statement it said, "We have closely reviewed the feedback from our customers and have identified an issue in our firmware that reduces boost frequency in some situations. We are in the process of preparing a BIOS update for our motherboard partners that addresses that issue and includes additional boost performance optimizations." It subsequently issued a BIOS fix, which is filtering through the motherboard vendors. You'll also want the latest Win 10 patch, which has been tweaked to work more effectively with PBO. Questions were then asked about reliability. Pundits wondered if AMD had pulled back on clock speeds to protect the chips from failure. AMD has flatly denied this: "Changes were not made for product longevity reasons."

AMD's new Ryzen 3000: Not quite as fast as advertised.

© AMD

This hiccup has given Intel the chance to take a swing at AMD. Ryan Shout, Chief Performance Strategist at Intel, said that "Despite some competitor solutions that the community is questioning, the Core i9-9900K and Core i9-9900KS are TRUE 5.0GHz processors." Intel also made sure everybody knew about AMD's problems by including them in a presentation at the IFA trade show. It also quoted a third-party report that claimed reliability issues were behind AMD's throttling back. These tactics are hardily sporting, but there is little love lost between the two companies. Intel's problem is that it has no immediate response to the Ryzen 3000, and it's starting to show.

We knew the Ryzen 3000 would be difficult to overclock; companies selling pre-selected chips, guaranteed to be stable when overclocked, found it tough to push the chips beyond 100–200MHz over base. AMD can currently sell every Ryzen 3000 it makes, and thanks to aggressive binning (the procedure that tests each CPU to see what model it can be sold as), it is working them hard straight out of the box. This might be bad news for overclockers, but it means the supply of faster models is as healthy as possible. AMD should have come clean about the mix of boost speeds; we were expecting all-core boosts as before, and were bound to notice the change. As yields improve, we hope this will get better. The bug in the BIOS firmware is an embarrassing slip. AMD has a little egg on its face, but as the benchmarks show, the Ryzen 3000 remains hugely competitive. **–CL**

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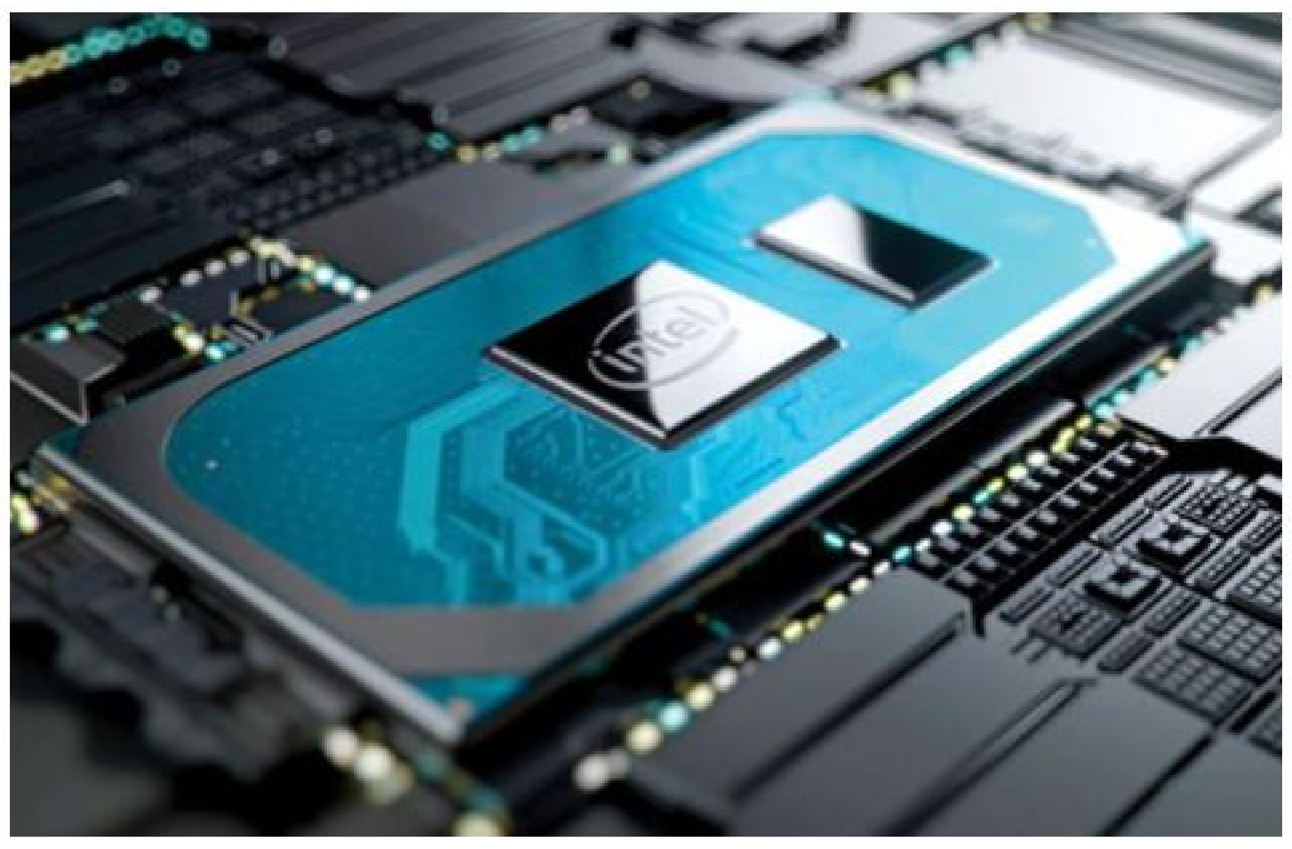

MORE 10TH-GEN INTEL

But not Sunny Cove

LAST MONTH, Intel kicked off its new generation of Ice Lake CPUs, carrying the new 10nm Sunny Cove microarchitecture, with 11 low-power chips for mobile devices. This month, the range has been filled out by another eight processors, again all low-power U-series and Y-series parts. They run from a Core i7-10710U with six cores and an all-core boost of 3.9GHz, down to a Core i3-10110U, with two cores running at 3.7GHz. The four new U-series chips also get support for LPDDR4X memory, with a 32GB maximum, and all get Wi-Fi 6 support. The U-series runs at 15W, while the more abstemious Y-series runs at 7W.

However, these aren't Sunny Cove parts. The new chips are all 14nm Comet Lake chips, which use the old Skylake microarchitecture. This means you don't get the impressive Gen11 graphics, the jump in instructions per cycle, the fatter cache, or any of the other Sunny Cove improvements. Intel claims the new chips are better suited to productivity and heavier workloads, and they do have useful clock speed bumps over the older Comet Lake parts (at the cost of more power). They also get Adaptix Dynamic Power Tuning, which adjusts clock speeds according to load and temperature. Intel reckons this can return an 8–10 percent boost in performance. But if you have any interest in gaming, you'll want the Sunny Cove 10th-gen chips over these—they are more than twice as fast at shifting pixels.

Nothing in the model name tells you which is which, unless you look closely. If it ends with a G, then a number, you've got a Sunny Cove part; this represents the level of the Gen11 integrated graphics. The Skylake architecture has made an appearance in every generation since the sixth. Why start the 10th with so many mobile parts? One reason is that the mobile market makes up 60 percent of the PC cake. The other conclusion is that Intel is still a long way from being ready with desktop parts. Next year, maybe. **–CL**

READY FOR USB 4.0?

FULL SPECIFICATION IS PUBLISHED

THE BODY RESPONSIBLE for laying out the specs of USB, the USB Implementer's Forum, has published the full specification for version 4.0, officially USB4, with no space. It blends in Thunderbolt tech, which was developed by Intel, later in collaboration with Apple, and mixed PCIe and DisplayPort signals into one serial stream. Thunderbolt never went mainstream, being expensive to implement. By mixing Thunderbolt into USB, Intel loses these payments, but gains exposure, including AMD mobos.

USB4 will use USB-C connectors exclusively. Data transfer rates are up to 40Gb/s, twice USB 3.2's rates, and eight times the original USB 3.0 rate. There are lessor modes of 10 and 20Gb/s for less demanding devices. It will be backwardly compatible with USB 2.0 and 3.2, and Thunderbolt 3. It can transfer video and data simultaneously, with bandwidth intelligently allocated. It'll also be excellent at charging, with USB Power Delivery a standard feature. However, don't expect any USB4 ports for a year or two. **–CL**

YET ANOTHER FACEBOOK LEAK

Five times bigger than the Cambridge Analytica one

A SECURITY RESEARCHER has found an unprotected server with a massive cache of Facebook data on it. The database contains 419 million phone numbers, including 133 million from the US. Most were linked to Facebook usernames, and many had real names, birthdays, and other personal data attached. The server's owner was informed, and the data taken down. Facebook claimed that "The data set is old and appears to have information obtained before we made changes last year to remove people's ability to find others using their phone numbers. The data set has been taken down and we have seen no evidence that Facebook accounts were compromised." Are we reassured? For over a year, millions of user details were left unguarded. Who collected the data, and why? Facebook is trying to convince the world that it can be trusted as it tries to launch its digital currency, Libra. A stream of data leaks continues to dog the company—whatever steps it took last year clearly need beefing up. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

TAPE'S NOT DEAD
Fujifilm's LTO-8 tape cartridges offer 30TB of compressed backup using nanocubic barium ferrite. Cost effective and useful.

CARBON CHIP
MIT engineers have built a 15,000-transistor RISC-V CPU using carbon nanotubes; in 2013 they managed 178 transistors.

ROBOT HUGS
The Cushybot One means you can interact with your child from anywhere. Adorable but spooky.

TRAGEDIES

TESLA LOCKED OUT
A server outage meant Tesla 3 owners couldn't get into their cars using the app, unless they were carrying the key card.

WIKI HIT BY DDOS
A huge denial of service attack powered by botnets took down the Wikimedia server for hours.

MOST DOWN-VOTES
An EA post about unlocking *Star Wars Battlefront* characters enters the *Guinness Book of Records*—for down-votes.

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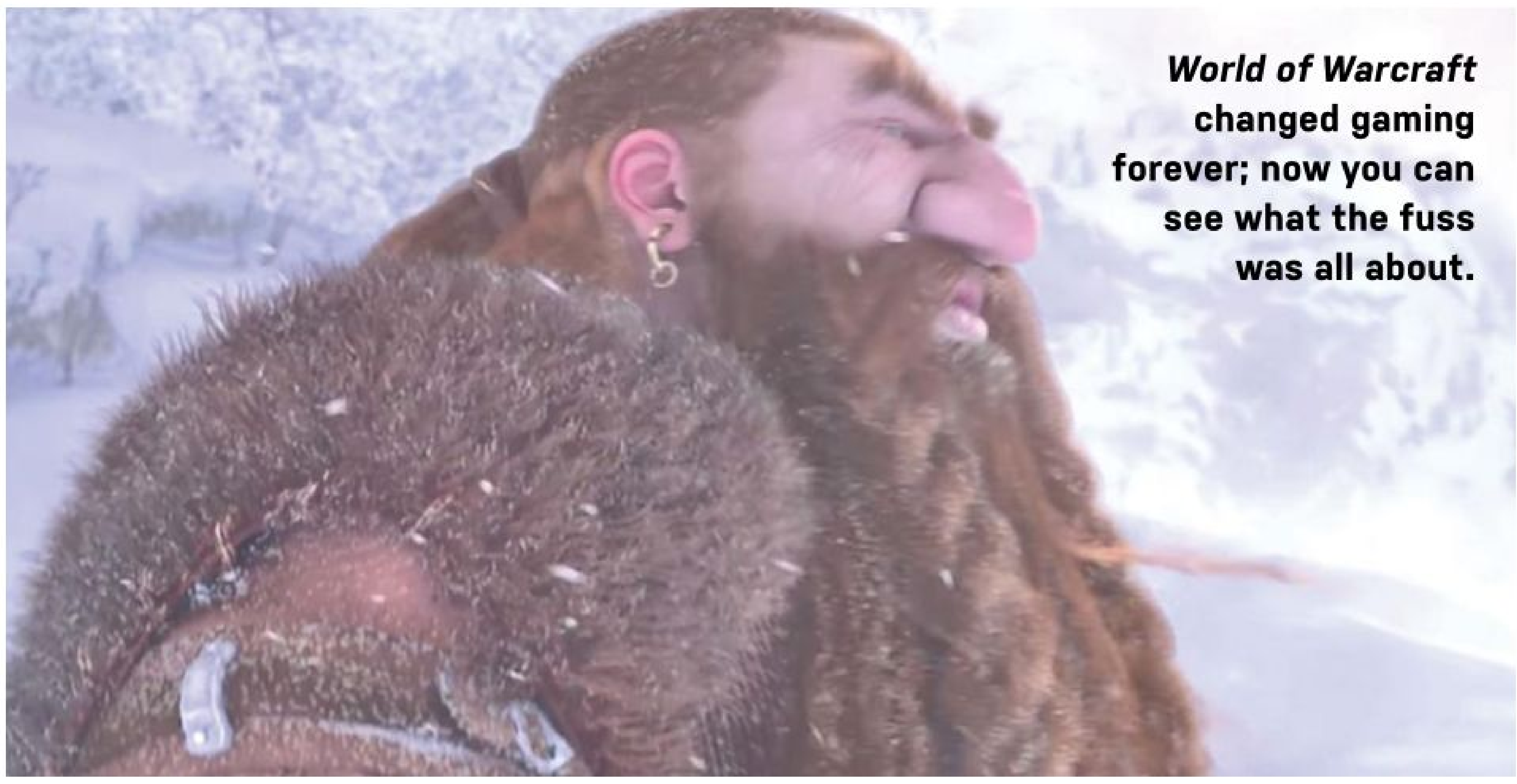
WoW Goes Back to Its Roots

A LOT OF PEOPLE have given an awful lot of time to Blizzard's *World of Warcraft.* Launched in 2004, *WoW* racked up 10 million accounts by 2009, making it the world's biggest MMORPG. By 2014, it had pushed this to 100 million accounts. It was a pivotal point in gaming: an online, interactive world, where players could co-operate in raids and quests. Over the years, it has had a series of expansion packs that pushed the game's capabilities and scale. The original had players of up to level 60; over the years this has reached 120. This, and the increased complexity, can make it daunting for newcomers. Many older players miss the simpler times of the original, too. Well, the release of *World of Warcraft Classic* turns back time, and enables you to play the original game, without any expansions. Its server will run alongside the existing game.

WoW Classic returns the game to as it was after patch 1.12.1, in September 2006. You are back to picking from the original eight races and nine character classes. This return to *WoW's* roots has been long requested by players. Many private servers tried to run the original. One, Nostalrius, attracted 800,000 accounts before it was closed down by Blizzard, only to reappear after a 200,000-signature petition reached Blizzard's president. Eventually, technical problems were sorted out, and the old game was ported to the modern server and client system, so it enjoys the security and performance of the latest version. Be warned: Battles are slower, and more lethal, and getting around the world can stretch your patience—you have to run there. *WoW Classic* is free if you have a *WoW* subscription, or $15 a month if you don't. **–CL**



***World of Warcraft* changed gaming forever; now you can see what the fuss was all about.**

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PowerToys Are Back

Back in the days of Windows 95 and XP, the operating system came with a set of utilities to tweak the way it works. These PowerToys disappeared with Windows Vista, but Microsoft is bringing them back via an open-source project on GitHub, which started earlier this year. The initial fruits are ready, with the first being a shortcut key guide, which brings up an overlay with the dynamic shortcuts for each application. The second is called FancyZones, which enables you to set custom zones for apps; you can then drag and drop apps into these, and they are automatically resized to fit. Ten more PowerToys are being considered for release.

20TB HDDs

Western Digital has released two new drives: the 18TB Ultrastar DC HC550 and 20TB HC650. These are the first drives to employ WD's new Microwave Assisted Magnetic Recording, MAMR, which uses a miniature microwave to aid accurate energy-assisted recording. It hopes to reach a data density of four terabits per square inch, which translates into 40TB drives. Toshiba is working on a similar system to break through the ceiling of Perpendicular Magnetic Recording tech. Just when you think data can't be packed into a smaller space, a new technology emerges that does it. Given the amount of data generated now, estimated at over 2.5 quintrillion bytes a day (that's 18 zeros), we need big storage.

IPHONE SECURITY BLOWN OPEN

Google and Apple argue over vulnerabilities

GOOGLE'S PROJECT ZERO aims to make zero-day problems (security vulnerabilities of such importance that engineers have zero days to fix them) difficult to pull off. Earlier this year, Project Zero was tipped off by Google's Threat Analysis team about a hacked website that was targeting iPhone users. It found 14 vulnerabilities across five exploit chains. The website was able to install malware with root access on a variety of iPhones, and could then steal data, log activity, even passwords. These vulnerabilities had been active for two years, on multiple iOS versions. Google alerted Apple, and waited for things to be fixed. Then Project Zero went public with a report on what it knew.

Apple was not happy. It claimed it hadn't been two years, but more like two months (it's a zero-day problem, remember Apple?). It also said it knew about the flaws, and was working on solutions before Google informed it. Apple claimed that "fewer than a dozen" websites were exploiting the vulnerabilities. Essentially, Apple's response was mere damage limitation. It didn't look good.

Even if Apple did fix things quickly, and the attack was, as it claims, "narrowly-focused" and politically motivated, it still caught thousands of people out. More worrying is what this means for the iPhone. It has always been considered one of the most secure pieces of consumer electronics; breaking in was notoriously difficult without Apple's help, even for the FBI. That is a precious reputation, and this appears to have tarnished it. Meanwhile, Android phones have been getting tougher to crack, thanks to a concerted effort by Google and a bug bounty program. In the murky business of dealing with zero-day exploits, the price for Android exploits now exceed that for iPhones. A sober thought. **–CL**

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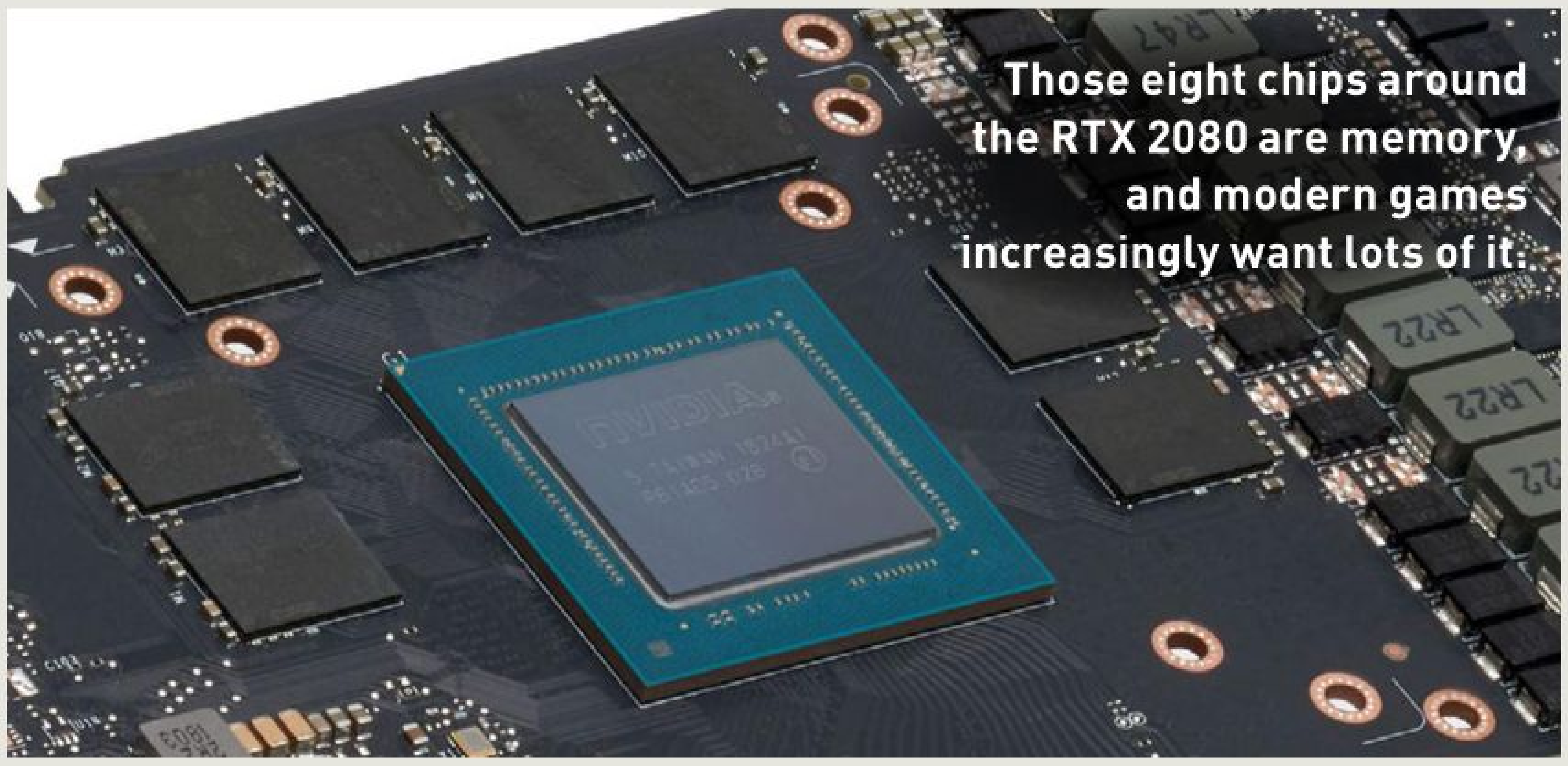
TECH TALK

How Much VRAM Do You Need?

IF YOU'VE BEEN AROUND PCS as long as I have, the old rule of thumb for how much memory you needed was easy: as much as you could afford. I remember building PCs in the '80s and '90s where you'd fill every slot.



Those eight chips around the RTX 2080 are memory, and modern games increasingly want lots of it.

© NVIDIA

Thankfully, memory requirements for most of us have tapered off. The exception is for games, where higher resolution textures and other enhanced graphical effects increasingly demand more video RAM. But how much VRAM do you really need?

There are several ways to look at that question. What is the minimum amount of VRAM you can get away with? What's the recommended amount? And if you're buying a new graphics card, should you get a model with more memory to future-proof it?

Let me take that last one first, because it's pretty simple. Outside of lower tier cards, these days we rarely have a choice in how much VRAM our GPU has. You pick a GPU like an RTX 2070 or RX 5700 XT and it comes with a set amount of VRAM—8GB for either card in this case. The previous generation GTX 1060 cards came in 3GB and 6GB varieties (and even 5GB in some countries), and AMD's RX 570/580 were both available in 4GB and 8GB trim—and the RX 560 came in 2GB and 4GB models. But if you're looking at a current generation mid-range or higher card, such as an RX 590 or GTX 1660, your GPU determines the amount of VRAM.

Regarding the first question—the minimum amount of VRAM you need—the answer is more nebulous. It depends on the game. Some work with 1GB of VRAM, though all recent GPUs have at least 2GB. Others want 2GB minimum and prefer 4GB. The biggest factor is the settings you use in game.

Texture resolutions are the biggest consumer of VRAM. Low resolution textures typically only require 1–2GB, medium quality textures usually target 2GB, high quality needs 2–4GB, and ultra quality textures can require anything from 4GB to 8GB. Some games break this down further into environment textures, character textures, and shadow textures. Generally, there's a noticeable jump in image quality when going from low to medium to high textures, but ultra versus high often doesn't result in a visible change unless you compare still images; even then, the differences are minor.

VRAM also appears important in ray tracing. On paper, the RTX 2070 has 22 percent more compute than the RTX 2060, and 33 percent more memory and bandwidth. That typically means the 2070 is 25 percent faster. But I've seen a few ray-tracing games where the gap can be quite a bit larger. Not that it matters, as the 2060 is usually below the playable level in such cases, but more memory and bandwidth also appears to be important for DXR enabled games.

Today, cards with 2GB of VRAM are starting to struggle. An old GTX 770 often can't break 60fps at 1080p, regardless of how far you turn down the settings. 4GB cards do OK, but you'll want to run at the high setting, not ultra. The bigger factor is your GPU. A budget GPU with tons of VRAM won't work well, and high-end GPUs don't give you an option for a low amount of VRAM. You're usually better off buying a faster GPU that comes with more VRAM than a budget card that has "enough" memory.

As for what we recommend, it's straightforward: Get at least 6GB of VRAM, and preferably 8GB. For AMD cards, the RX 590, Vega, and new RX 5700 series all have 8GB, while the Radeon VII has 16GB. For Nvidia, the GTX 1660 series and RTX 2060 have 6GB, while the latest RTX Super cards have 8GB. Personally, I'd skip Nvidia's 6GB cards and stick to the RTX 2060 Super or faster as a minimum.

In other words, the mid-range and high-end GPUs we recommend are all fine. And if you're on a budget, move to a faster GPU before worrying about more VRAM.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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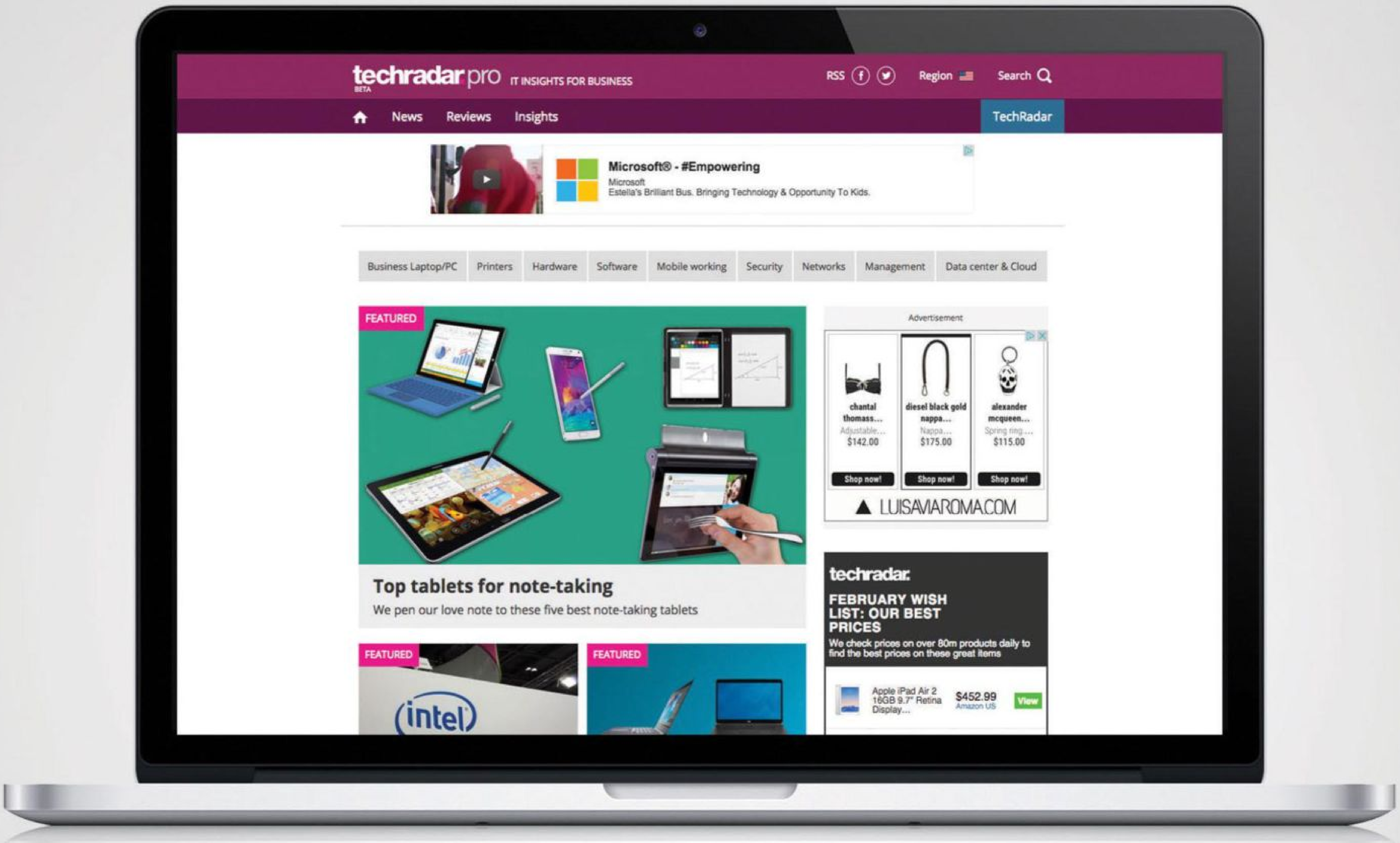
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diesel black gold nappa... Nappa... $175.00
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Alex Campbell

OPEN SOURCE

Linux is Going to Get the Good FAT

MICROSOFT HAS ANNOUNCED that it will begin open-sourcing the proprietary exFAT filesystem for integration with the Linux kernel. This is easily one of the biggest and most consequential contributions Microsoft has made for the Linux community that will directly affect desktop users.

If you've been using computers for any amount of time, the FAT32 filesystem should ring a bell. The File Allocation Table (FAT) filesystem has been around since the days of DOS and Windows 3.11. However, different iterations have passed throughout the years, following the capabilities and memory address capacity of processors. The original FAT was 8-bit, while FAT16 saw use in PC DOS and up to Windows 3.11. The 32-bit FAT32 was a staple for storage during the proliferation of 32-bit systems, with a maximum drive capacity of 2TB. The modern exFAT filesystem represents the 64-bit address space that modern systems have, and it can handle disk sizes of up to 512PB (petabytes).

For consumers, these huge volume sizes mean very little—it's unlikely anyone is ever going to need anything like that amount of storage on their home PC. However, if you were going to go out and buy an SD card, it would come preformatted in either FAT32 (for SDHC up to 32GB), or exFAT (for SDXC over 32GB). The same holds true for most USB flash drives.

For Linux users, exFAT has been readable and writable for quite some time through Linux's filesystem-in-userspace (FUSE). While FUSE provides access, it really only works in userspace, as the name implies. This has one big consequence in that the filesystem check (fsck) utility cannot fix errors on an exFAT partition. While there is a utility to check for errors (exfatfsck), it cannot repair any found errors.

Microsoft's decision to open up the exFAT specification under the GNU General Public License will provide native support for one of the most prolific filesystems in the consumer space. This is a potential big win for Linux users, although the current implementation is still under development. (In fact, kernel developer Christoph Hellwig called an August code addition a "pile of crap" on the kernel.org mailing list.)

Before you get too excited—I mean what's more exciting than filesystems, right?—I wouldn't look to install your base system or /home folder on exFAT. As it stands, exFAT does not support POSIX permissions, which is a key part of UNIX and Linux system security. Basically, exFAT filesystems are exposed in mode 777, which means that any user can read, write, or execute any file or program on the filesystem. Clearly, this is far from ideal for a user, and downright dangerous for the root filesystem. So, for most Linux users, I would stick with the tried-and-true ext4 for a daily filesystem. For most people, exFAT should be resigned to USB thumb drives and SD cards, where it belongs.

While not advisable for use on a Linux system, exFAT is ideal for any device or partition where you want maximum portability between Windows, MacOS, Linux, and mobile operating systems. In this sense, the only time you might format a non-removable partition in exFAT is if you dual-boot a system and want to be able to easily share files between them without regard to permissions. If you work with photographs on a dedicated drive and work both in Linux and Windows, for instance, you'll easily be able to get to those photos from either operating system, without having to boot into Windows to fix the drive if something goes awry.

This latest decision from Redmond is yet another gesture that shows Linux is being embraced by Microsoft. Linux is very popular on Microsoft's Azure cloud, the Windows Subsystem for Linux has brought Linux environments to the Windows world, and GitHub (which was acquired by Microsoft) is still a major host for open-source projects.

I don't expect Microsoft to readily loosen its grip on key proprietary products, but it's good to see a willingness to play a little nicer with other systems.

> Microsoft's decision provides native support for one of the most prolific filesystems.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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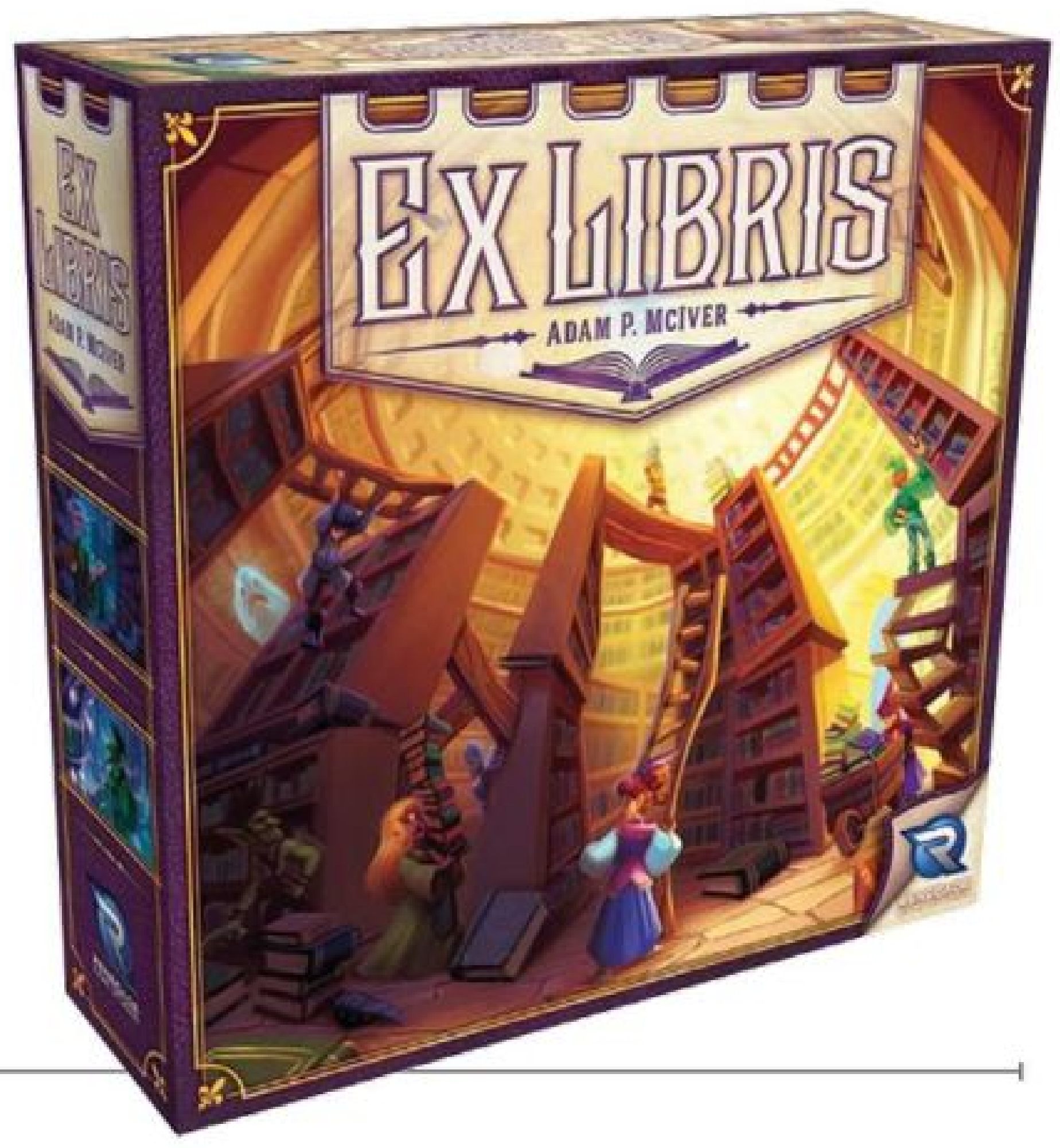
THE LIST

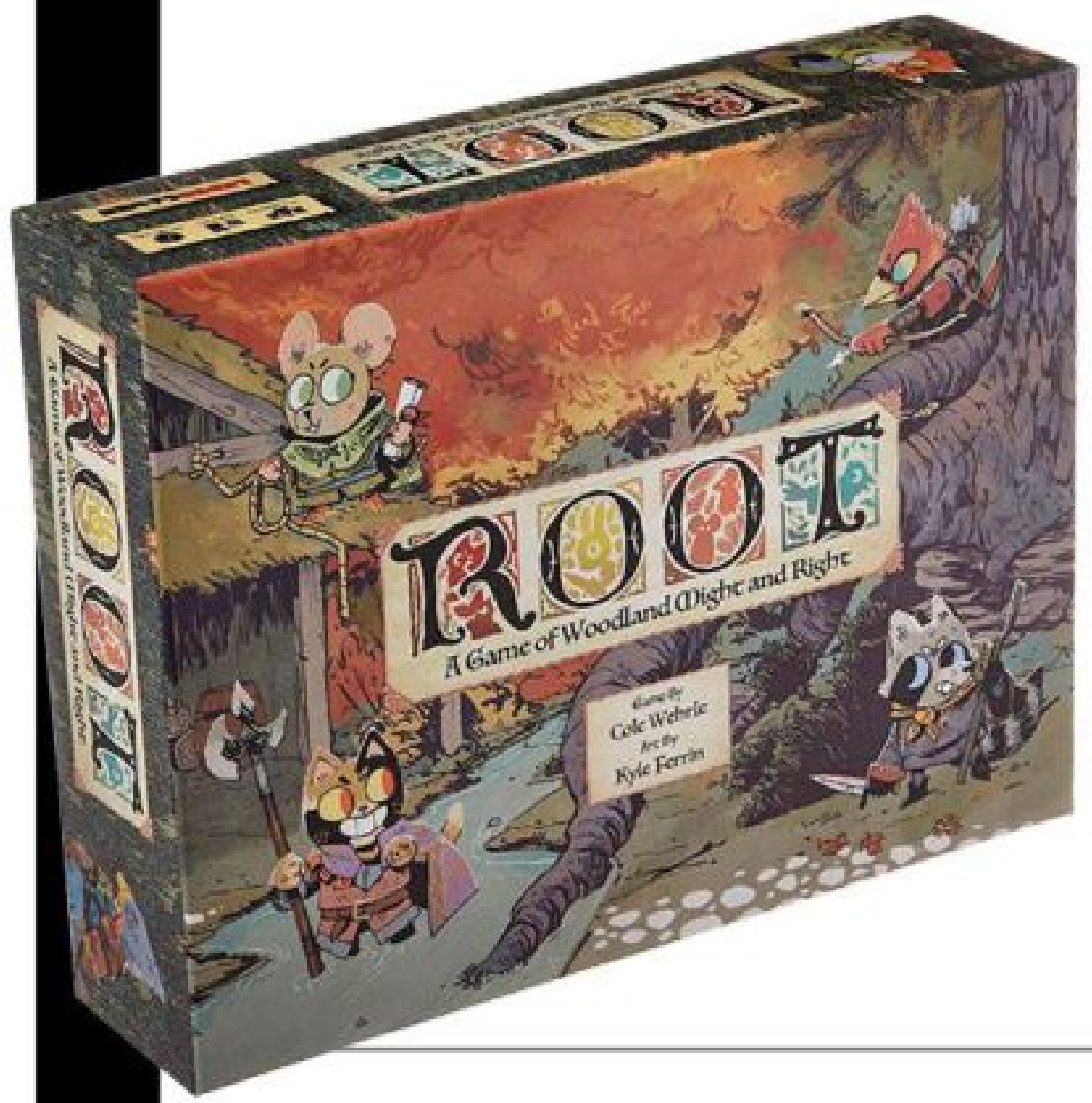
8 BEST BOARD GAMES WORTH PLAYING TODAY


EX LIBRIS
ADAM P. MCIVER

8

EX LIBRIS

Sumptuous art, a unique concept, and great comedy make book collecting far more fun than it should be.


ROOT
A Game of Woodland Might and Right

7

ROOT

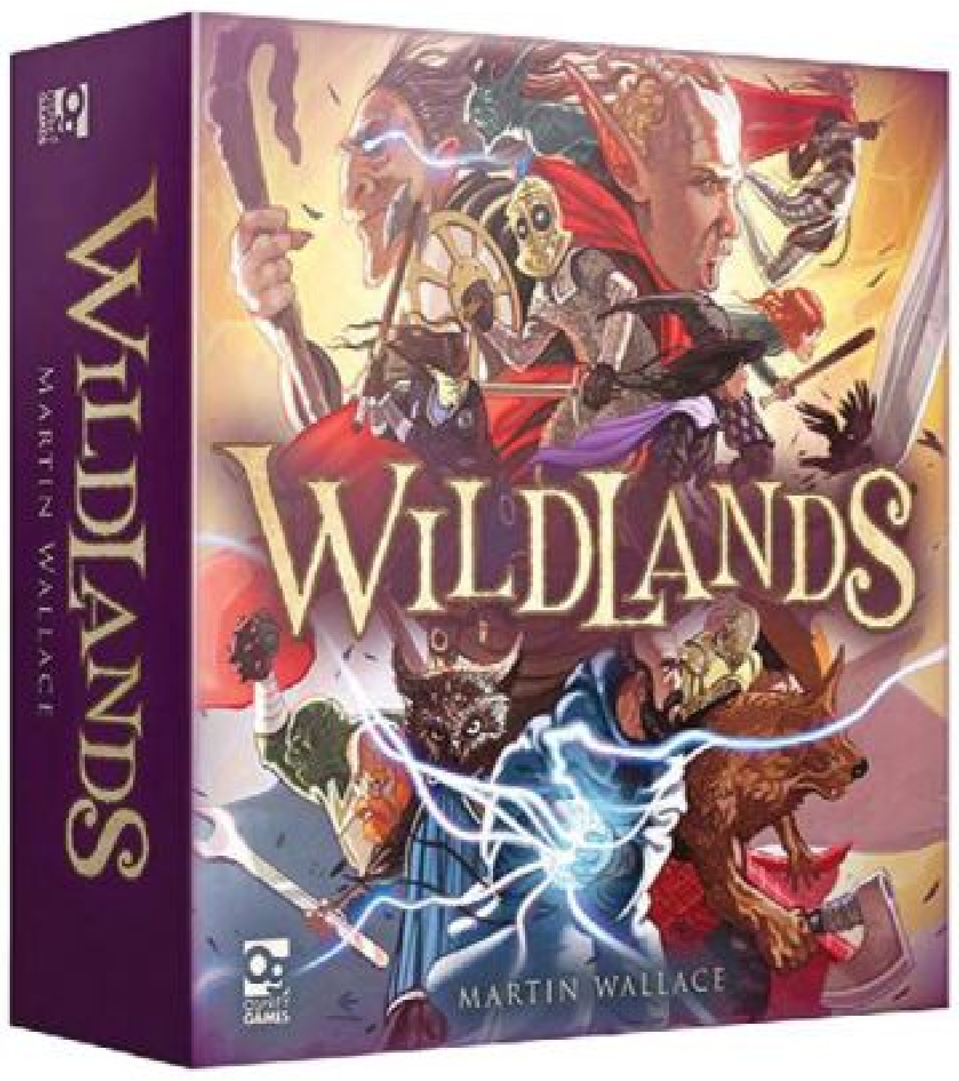
The cutesy woodland facade conceals a deep asymmetrical strategy game that benefits from multiple playthroughs.

XCOM
THE BOARD GAME

6

XCOM: THE BOARD GAME

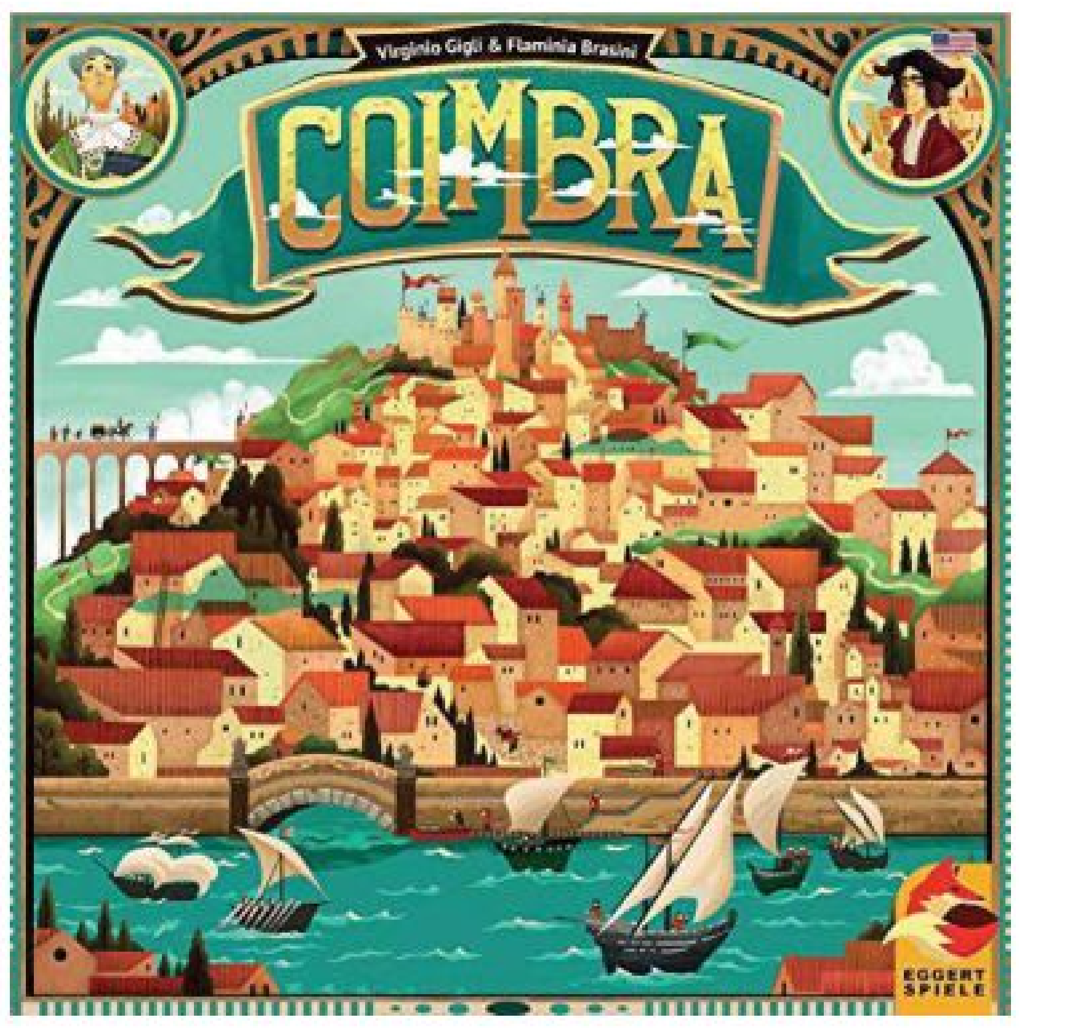
An incredibly tense co-op game based on the PC classic, which handles base attacks and UFO arrivals in real time.


WILDLANDS
MARTIN WALLACE

5

WILDLANDS

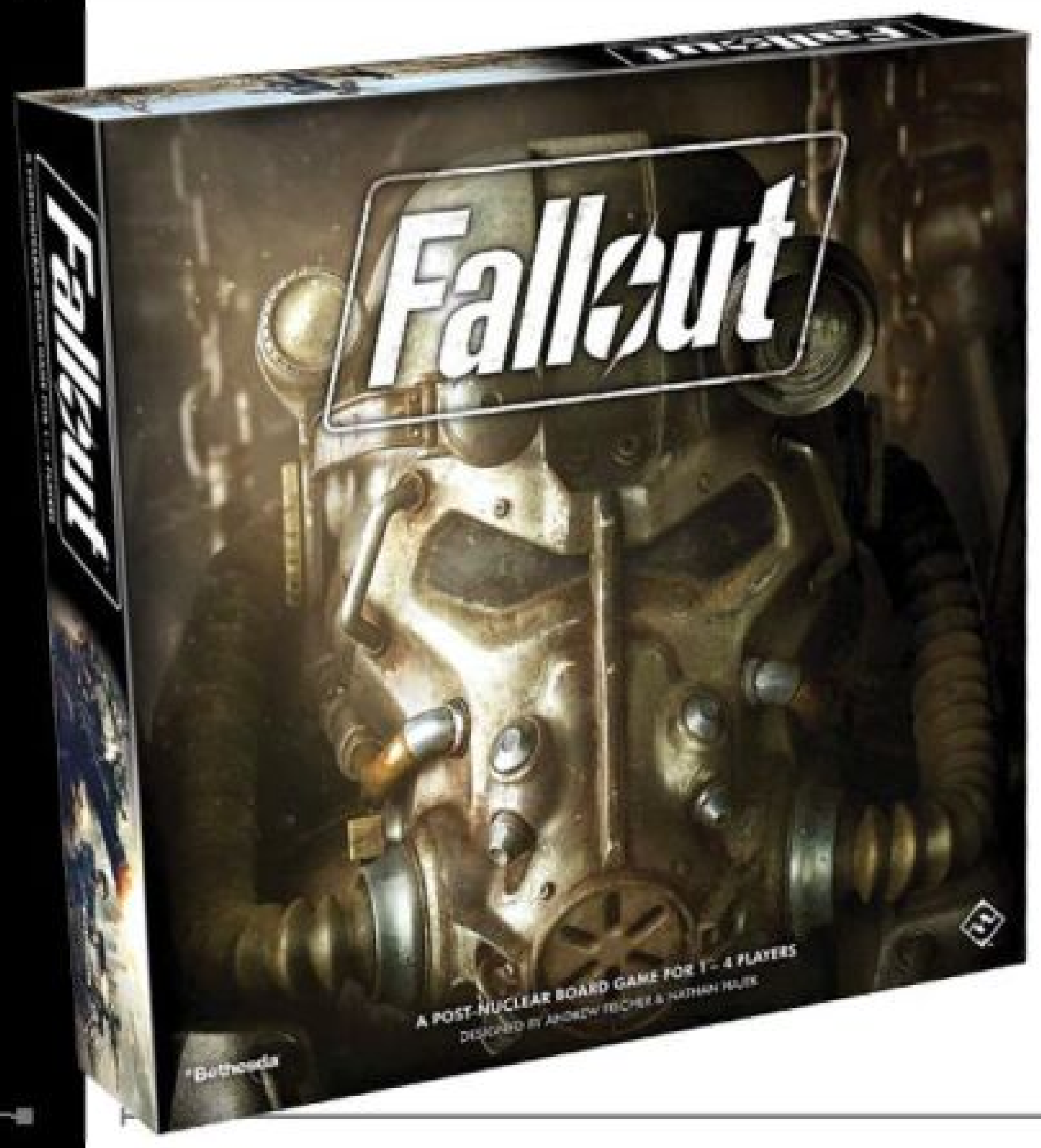
An interesting departure from normal strategy tropes, Wildlands replaces dice with deep tactical strategy.



4

COIMBRA

Clever core dice mechanics and a beautiful eye for design make for a great Civ-like strategy game.



3

FALLOUT: THE BOARD GAME

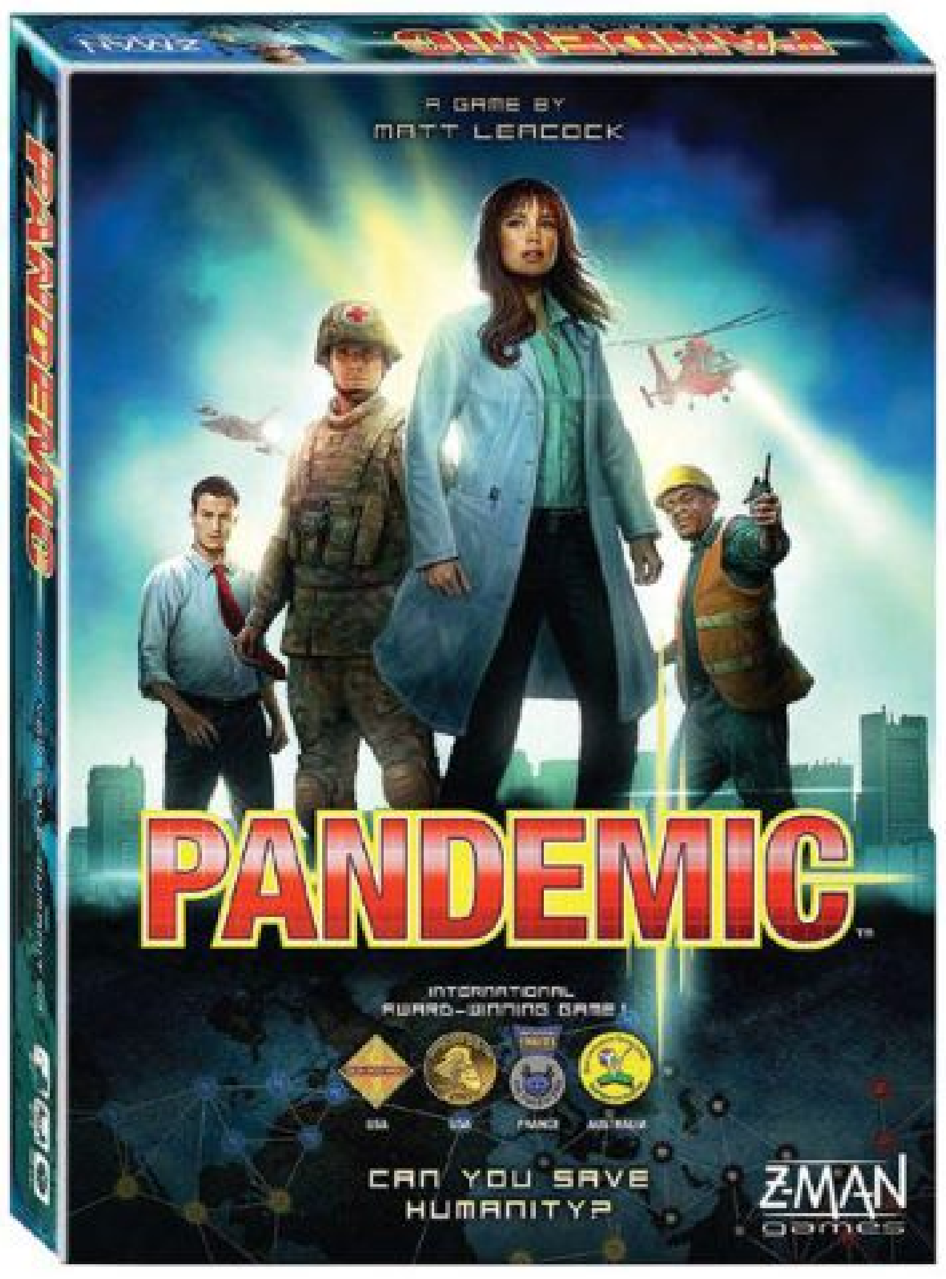
Delivering an authentic *Fallout* experience on the tabletop, this is a great game even if you're not a fan of the series.

BETRAYAL AT HOUSE ON THE HILL

2

BETRAYAL AT HOUSE ON THE HILL

Explore an eerie mansion, room by room, to solve missions that change each time you play.


PANDEMIC
CAN YOU SAVE HUMANITY?
Z-MAN games

1

PANDEMIC

Take command of a team of experts trying to contain a slew of diseases in this fiendish but addictive co-op game.

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TALKING

BY **CHRISTIAN GUYTON**

AMD Talks About the Tech Behind New Radeon GPUs

We speak to AMD's Scott Wasson about the new features on the RX 5700 and RX 5700 XT

The RX 5000 series of Radeon GPUs has been available for a few months now, with mixed response from critics and gamers alike. The RX 5700 XT is undeniably a pretty great graphics card at its $400 price point, although competition from Nvidia's "Super" RTX cards has kept the market on its toes. What does AMD do to set its cards apart, then? Two things: Radeon Image Sharpening and Radeon Anti-Lag.

With over a decade and a half of experience in the industry, Scott Wasson is one of the most qualified people around when it comes to AMD hardware.

Maximum PC: We're interviewing Scott Wasson from AMD. After over 15 years of testing and writing about technology, and founding two prominent tech publications, Scott joined AMD's Radeon Technologies Group several years ago. As Senior Manager, Product Management in Radeon Software, Scott drives the development of features that improve the user experience for gaming and graphics. What we want to know is, how does Radeon Image Sharpening on the RX 5700 and RX 5700 XT work? How does it improve games?

Scott Wasson: For various reasons, lots of gamers these days find themselves looking at in-game visuals that aren't as crisp as they should be. For example, high-PPI displays are becoming more common, but a lot of times, gamers may discover that it's tough to get consistently smooth and fluid frame rates at resolutions like 4K. Oftentimes, the solution is to run your games at a lower resolution and scale up to fill the display area, but doing so results in soft, fuzzy visuals. Similarly, antialiasing techniques such as temporal antialiasing (TAA) are incredibly popular in newer games. Such AA methods offer a nice mix of performance and image quality, but they can make game images a bit blurrier than they should be.

We created Radeon Image Sharpening (RIS) to restore the clarity to game visuals. If you run your game at a lower resolution, such as 2560x1440, and scale up to 4K, enabling RIS will make game visuals look more like native-resolution images. RIS uses a contrast-adaptive sharpening filter that avoids some of the worst artifacts of typical sharpening methods, such as halos around high-contrast edges. This adaptive filter also plays well with virtually any antialiasing method, preserving the soft gradients along high-contrast edges. Meanwhile, the performance overhead for RIS is very low, typically less than 1 percent on average[1], so you aren't paying a big performance tax for the improved clarity.

Since it's a feature of our Radeon Software Adrenalin drivers, RIS doesn't require specific support from the game. Radeon Image Sharpening works on Radeon RX 5700 series graphics cards in games based on the DirectX 9, DirectX 12, and Vulkan APIs. Even better, we have released an open-source version of our contrast-adaptive sharpening filter on GPUOpen.com for developers to integrate into their games as they wish.

MPC: For our readers who aren't already aware, what is input lag?

SW: In gaming, input lag is the delay between when you provide an input—the click of a button or the swipe of a mouse—and when you see a response on screen. The bigger that delay, the less immediate and in-control you'll feel as you're playing a game. The smaller the delay, the more connected you'll feel to what's happening in the game. So, reducing input lag is a key goal for Radeon Software, as you might expect. We want gamers to have the best experience possible while playing.

MPC: And Radeon Anti-Lag: We've seen it promoted by Fnatic, but how does it work, and what are the visible impacts of it?

SW: Radeon Anti-Lag is a software optimization that's meant to reduce input lag in games. There are many sources of input lag, from your input devices through the computer and out to your display. We can control a portion of that input-to-response chain in software. Typically, that portion we can control in software has involved a fixed delay while waiting for the computer to produce two or three frames of animation. The way that most competitive gamers have reduced lag has been cranking down the image quality to achieve very high frame rates. Shorter frame production times mean less total lag.

With Radeon Anti-Lag, we can reduce input lag by as much as 80 percent[2] of the time required to produce a full frame of animation. We do so by watching the work happening in real time on each frame, and making sure the CPU's work doesn't get too far ahead of the GPU's work. By keeping the CPU and GPU working more closely in parallel, we can reduce the amount of wait time between when an input is registered by the CPU and when a frame is completed by the GPU and sent to the display.

The result should be a more connected feeling between your inputs and the responses from your computer. This effect is most easily felt when your frame rate is somehow challenged, particularly when the GPU is taxed by the game visuals. In those cases, systems with Radeon Anti-Lag should be less laggy and just play better than they otherwise would.

MPC: How does Radeon Anti-Lag affect CPU performance?

SW: Although Radeon Anti-Lag is pacing the CPU work while gaming, our goal is to have a negligible impact on frame rates. If you check it out, I think you'll find that we've largely achieved that goal across the most popular games. There may be a few cases where the frame rate is reduced by a few frames per second, but the lag reduction we deliver is usually much, much greater than any FPS hit you'd see.

MPC: And finally, how can Radeon gamers try out these two new features?

SW: Radeon Image Sharpening can be enabled in Radeon Software Adrenalin 2019 Edition under the "Display" tab. Toggle on "GPU Scaling" and "Radeon Image Sharpening" to experience crisper graphics when gaming.

Similarly, Radeon Anti-Lag can also be enabled in Radeon Software under the "Gaming" tab, or through the Radeon Overlay in game. Simply hit the hotkey (Alt-R) to bring up the Overlay, click the "Game Experience" menu item, and click the toggle switch to enable Radeon Anti-Lag.

MPC: Thanks so much for talking to us about this, Scott. It's been very informative.

Radeon Software

If you have an AMD CPU or GPU in your system and you've never tried out AMD's proprietary software, you're missing a trick. The Ryzen Master software provides excellent tweaking potential for Ryzen CPUs, Radeon RX graphics cards, or any memory. Ryzen Master offers plenty of settings to meddle with, primarily in the interest of overclocking for better performance, but also including elements such as core management for Ryzen processors, or manual memory timing adjustments.

The software Scott discusses in the interview is Radeon Software's Adrenalin 2019 version, which allows access to a number of nifty features that improve your gaming experience. The Radeon Image Sharpening and Radeon Anti-Lag functions talked about in the interview are just the start; one feature that isn't mentioned is the updated Radeon Chill program, which uses intelligent monitoring to reduce system noise and power consumption, without resulting in a noticeable decrease in performance. AMD claims that Adrenalin 2019's updated version of Radeon Chill provides more than double the potential energy savings than the previous version, so it's definitely worth a look.

Another feature of Adrenalin 2019 is AMD Link, which enables games to be played on any Radeon PC via any mobile device or Android/Apple TV connected to the same Wi-Fi network, allowing for direct streaming to a smart TV or phone. An extra aspect of AMD Link is Radeon ReLive, which enables users to stream clips of captured gameplay from their PC to their TV screen. Link is a great way to indulge in some couch gaming, or finally play that party game you bought on Steam, before realizing that six people clustering around a monitor at your desk wasn't a great plan for some evening entertainment.

Note 1: As low as 1 percent average lower performance with Radeon Image Sharpening on versus off using Radeon Software Adrenalin 2019 Edition 19.7.1. Testing conducted by AMD Performance Labs as of June 4, 2019, on the 8GB Radeon RX 5700, using a test system comprising an Intel i7-9700K CPU (3.6GHz), 16GB DDR4-3,200MHz memory, and Windows 10 64-bit. Performance may vary.

Note 2: Based on testing by AMD Performance Labs as of June 2019, using the Arudino benchmark test in Apex Legends *at 88fps, and the Radeon RX 5700 XT graphics card, with Radeon Anti-Lag enabled. Performance may vary based on use of latest drivers and other factors.*

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> 1903 Update
> USB Problems
> Blue Screen of Death

Blocked Update

Hey Doc, I have a Digital Storm PC running Windows 10 Home 64-bit, with Intel Z270 chipset and Intel Core i7-7700, 16GB RAM, 240GB SSD, and 2TB HDD. Here's my issue: Windows 10 Update 1903 is not compatible with the Intel Rapid Storage Tech. It advises me to update the driver. However, when I go to the Intel site, it has a disclaimer that I should check with the manufacturer to see if the onboard driver is a "custom" one, and follow their instructions.

I contacted Digital Storm tech support and it spent two days trying to figure out what to do. No luck. I was directed to use the Microsoft Update Assistant, which got 91 percent through the download before stopping with error code 0x1900209.

I notified tech support and again they couldn't advise me on what to do. I am hesitant about applying the current Intel Rapid Storage driver due to the disclaimer about a custom driver. My tech support guy tells me they are seeing a lot of this, and have no workaround for the 1903 Win 10 Update.

I want to keep my Win 10 OS updated for security and stability, but I don't want to brick my motherboard with a driver that is incompatible. So, where do I go from here?

–Ben

THE DOCTOR RESPONDS: Your first port of call was Digital Storm, but in your original email you reveal that your mobo is an Asus ROG Maximus IX Hero. We took a trip to the Asus website, and lo and behold, we found it offers an updated Intel Rapid Storage Technology driver—version 15.9.0.1015, which exceeds the minimum requirements laid down by Microsoft at https://support.microsoft.com/kb/4514156 (15.5.2.1054 or later). Go to www.asus.com/support/Download-Center/ where you can enter "maximus ix hero" to locate the driver under "Driver → Utility → SATA." Disable your ad-blocker for the site if nothing shows after selecting Windows 10 64-bit from the "Please select OS" drop-down menu.

If you're still nervous about applying this update (unless Digital Storm has done some further tweaking of its own, which is unlikely, this driver should be the one you need), first take a precautionary drive image of your system using a tool such as Macrium Reflect Free (www.macrium.com/reflectfree.aspx). Be sure to create recovery media under "Other Tasks → Create Recovery Media"—it'll fit on a CD or 1GB flash drive.

Once done, update the driver and attempt to install the 1903 update again. If things somehow go drastically wrong, boot from the recovery media, and restore the image, but we suspect the Asus driver is the update you need.

USB Issues

Hi Doctor! For as long as I remember, USB sockets start refusing to work properly as the PC gets older. For example, if I plug in a flash drive next to my Logitech mouse and keyboard controller, the mouse becomes slow and intermittently unresponsive until I remove the drive. Similarly, sometimes I have to plug a USB HDD into a different bank of sockets for it to connect. When I remove it, who knows which sockets will work, and when they'll go back to normal? Another USB 2.0 device—a glucometer—doesn't work in a USB 3.0 socket.

I've Googled the problem and found fixes for seemingly dead sockets—but that's not me. Both PCs have fresh Windows 10 installs, I've tried disabling power saving, and have updated drivers (all up to date).

Why do USB sockets do this? Is there a workaround? I ordered an Orico four-port hub for 10 bucks—is that a workaround by freeing up three PC ports? **–Bubbator**

THE DOCTOR RESPONDS: There are probably several things going on, and while it's tempting to blame failing USB ports, the likelihood is that you simply need to sit down and rethink how you use your ports. You've sensibly followed basic troubleshooting advice—we're going to assume that when checking for power management issues, you also disabled selective suspend under "Power Options"—look in the current plan's advanced settings under "USB settings → USB selective suspend setting." You say you've checked drivers are up to date; we also assume you checked your PC/mobo's website for the latest chipset or USB drivers.

Interference between wireless controllers and other USB devices is more common

↘ submit your questions to: doctor@maximumpc.com than you might think. It sounds like you have your Logitech controller plugged into a front-mounted port, so we recommend plugging it—along with any other permanently connected devices—into the rear ports. This leaves the front-mounted ports for those devices—including the USB flash drive—that you only occasionally need to plug in.

Your USB hard drive problems may be linked to its power needs, particularly if it's drawing power from the USB port. This would explain why it only intermittently works on certain USB ports depending on what else is plugged in and drawing power. You might also want to check for potential resource conflicts if this happens again: Take a trip to Device Manager, expand "Universal Serial Bus controllers," then double-click each controller, and if you can see a "Resources" tab, select it to see if there are any conflicts. Again, the solution is to plug your drive in somewhere else.

Next, eliminate the possibility of a physical issue—rear ports mounted directly on the motherboard are usually less prone to issues than front-mounted ones connected by cable. After taking antistatic precautions, power down, open your case, and check the cable connecting the front ports to your motherboard is connected securely. Also look for a "wiggle" when plugging in a cable—either to front or rear ports—this indicates a connection may be coming loose. Rather than upgrade your entire system, investigate purchasing a PCIe USB adapter—prices start from $15, depending on the number of ports and speed you need.

4GB+ Persistence

I'm trying to install Linux to a USB drive, so I can test different distributions without mucking up my system. About 10 years ago, I used to play around with Linux, and I'd have multiple distros on a USB drive that I could swap between and try out, and they would retain their state when I installed programs, changed settings, and so on. I lost that drive, and now when I try to do it, the installs act like they're on an optical disk, so I lose the persistent state, and every reboot, they act like a clean install. Any help would be appreciated—any distro is acceptable. **–Chad**

RTX 2060 super

The Nvidia 2060 Super is a good step up from a misbehaving Vega 56 GPU.

© NVIDIA

THE DOCTOR RESPONDS: The Doc has spent more time than he cares to admit playing around with persistence and USB flash drives. Life is sweet and simple if you're happy to make do with no more than 4GB persistence storage: Just download and run UNetbootin on Windows, Mac, or Linux (https://unetbootin.github.io), select your chosen flavor of Ubuntu, and set "Space used to preserve files…" to 4096MB before clicking "OK."

Things are trickier if you need more storage. UNetbootin stores persistence in a file, which thanks to FAT32 limitations, can't be larger than 4GB. The solution lies in following a method that uses a partition for persistence. This requires access to an Ubuntu system—another Ubuntu live environment will do.

First, download your chosen flavor of Linux in ISO format (the Doc recommends the latest version of Ubuntu 18.04 LTS from www.ubuntu.com/download/desktop) to your "Downloads" folder. Then open a terminal window and type the following commands to install the mkusb tool:

```
$ sudo add-apt-repository universe
$ sudo add-apt-repository ppa:mkusb/ppa
$ sudo apt-get update
$ sudo apt-get install mkusb mkusb-nox usb-pack-efi
```

Once done, issue the following commands:

```
$ cd Downloads
$ sudo mkusb ubuntu-18.04.3-desktop-amd64.iso p
```

Substitute "ubuntu-18.04.3-desktop-amd64.iso" with your downloaded ISO filename, and don't forget to keep the "p" for persistence at the end.

Type "e" when prompted for your version of mkusb. Your USB drive should be listed; click "Select target device in the next window" to select it—typically by pressing 1 and hitting Enter. Check the box and click "Go." Press "g" for GPT and "OK" to avoid installing updates automatically. Press "i" for ISO file, then select 75 for persistence, leaving 25 percent of the space for an NTFS partition you can use to swap data to and from the drive with any OS. Click "OK" and let mkusb create your Linux USB drive. Job done!

BSOD Workaround

My Gigabyte Vega 56 hard resets my PC at random times after it's been on for hours, plus I also get a BSOD saying "Thread stuck in device driver." I was told by Gigabyte that my PSU was probably the problem—although it's a new Corsair CX600, I bought a Corsair HX850, and I still get the BSOD error at random times. My full system spec is: Asus ROG STRIX B350-F Gaming, Ryzen 5 1600, 16GB ADATA RAM, 512GB M.2 NVME SSD, Windows 10. **–Joshua Hall**

THE DOCTOR RESPONDS: As you've surmised, it's your Gigabyte Vega 56 graphics card that causes this problem. The web is littered with complaints about the same error you're seeing coupled with this card and its bigger brother, the Vega 64. Sadly, none of the fixes are universal. Step one is to investigate the driver you have installed via Device Manager—right-click your graphics card under "Display Adapters," and choose "Properties → Driver tab." The latest driver provided by Microsoft is two years old—17.7—and seems the most stable version, although some people report success running drivers as late as 18.5.1 (www.guru3d.com/files-details/amd-radeon-adrenalin-edition-18-5-1-driver-download,3.html).

If you're struggling to roll back to a Microsoft-supported driver, take an image of your current installation, then try a clean install of Win 10, leaving the Microsoft-installed driver in place to see if it resolves the problem. If it doesn't, restore your image to bring back your current Windows install.

You might also want to keep an eye on the temperature of your graphics card, as some have complained that they run far too hot—if you have access to Radeon Settings, use the Radeon Overlay's Performance Monitoring tool (press Alt-r followed by Ctrl-Shift-0) to view it, or try MSI's Afterburner tool (www.msi.com/page/afterburner). If the temperature spikes just before crashing, investigate additional cooling for the card, like the ARCTIC Accelero Twin Turbo II (around $45).

If all else fails, consider replacing the card with a more stable, up-to-date alternative. The Nvidia 2060 Super is a good step up for 1080p gaming, or plump for the AMD 5700 or 5700XT if you're wedded to Radeon graphics.

LAST NAME
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50

ESSENTIAL FREE APPS

Whatever you want to do, do it, and pay absolutely nothing in the process **BY ALEX COX**

FREE: that's the magic number. At least, it is when it comes to PC software. Why break the bank populating your PC with applications when enterprising individuals and organizations have created a raft of software that does the job adequately for not a single dollar down?

Now, we're well aware that there are several different categories of free software. There's the stuff that comes from the open-source community, which is usually a little rough around the edges, owing to its many-cooks approach. But open-source software has its own advantages: Sometimes it's home to experimental features that those in the commercial market might hold back on; sometimes it's designed for a niche that commercial developers can't profit from. There's also that slight guarantee that your software is going to stay free—while it might take an age to update and basically come with no warranty, open-source software suddenly attempting to dig around in your wallet is a rare occurrence.

The other side of the coin is "free" software, in quotation marks. There's a swathe of it in this list, but we've done our best to dodge anything too feature-light. Essentially, as has been the case for decades, software publishers often offer a taste of the goods in an effort to get you hooked enough to buy the real thing. Often, that taste is adequate on its own. Sometimes, it's not really a taste for you as much as it is for the business market, where expensive per-seat licenses can be a real money-spinner. You can have the software, but these guys need to pay.

Whatever the reason for a package being free (or "free"), we've tried to avoid picking out any time-limited trials or painfully poor options in this collection. There are 50 options for 50 distinct jobs—and 50 alternate suggestions, if our top pick doesn't give you exactly what you need. It is entirely possible to populate a PC with completely free apps—and a great many of these are cross-platform, so if you're really on the free side of the fence, you can run them on a Linux machine, too.

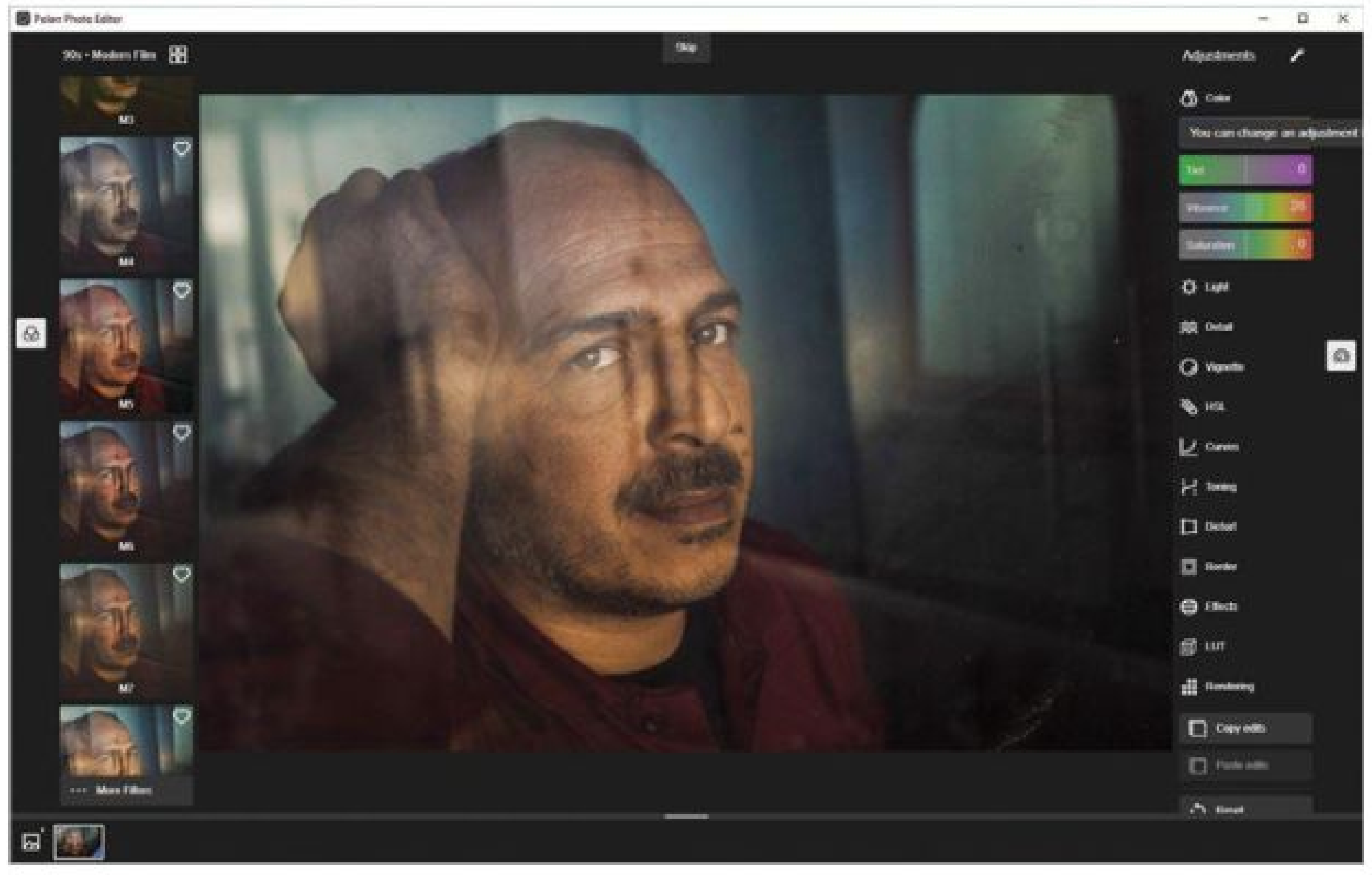
CREATIVITY

1
PHOTO EDITING
POLARR
http://polarr.co

Polarr has crept up on us over the past few years, but since it made the jump from mobile to PC app, it's proved to be one of the coolest and most capable photo-tweaking tools available, paid or not.
Alternately: **Adobe Photoshop Express**

2
IMAGE EDITING
GIMP
http://gimp.org

Stupid name aside, we've known for about a decade that Gimp's Photoshop-esque toolset and laundry list of filters make it an essential desktop tool. Save often, because it can decide to be flaky at a moment's notice.
Alternately: **Pixlr**



Polarr's filters give any image a professional touch in seconds.

3
DIGITAL PAINTING
KRITA
http://krita.org

Best enjoyed with a pressure-sensitive tablet, but viable for anyone who wants to create art with a mouse, Krita is an surprisingly accomplished paintbox as perfectly suited to illustrators as it is to any budding Bob Ross.
Alternately: **MyPaint**

4
VECTOR ART
INKSCAPE
http://inkscape.org

Pixels be damned: With Inkscape, you can create entirely scalable graphics and tweak text to your heart's content, making it perfect for generating logos and such. Inkscape is analogous to Adobe Illustrator (although it's a whole lot more free), and it's also fully SVG compliant.
Alternately: **Gravit Designer**

5
MUSIC MAKING
CAKEWALK
http://bandlab.com

Back from the dead somewhat, Cakewalk recently came under new ownership—and those owners decided that the app was best given to the world for free. Pro-level recording, all the tools you need to mix and master tracks, not to mention a host of software instruments and effects.
Alternately: **Ardour**

6
WRITING
FOCUSWRITER
http://gottcode.org/focuswriter

A beautiful, serene background image. The clickety-clack of a typewriter accompanying your keystrokes. You, your words, and no ugly distractions. If there's something you need to get written, you should forget big clumsy

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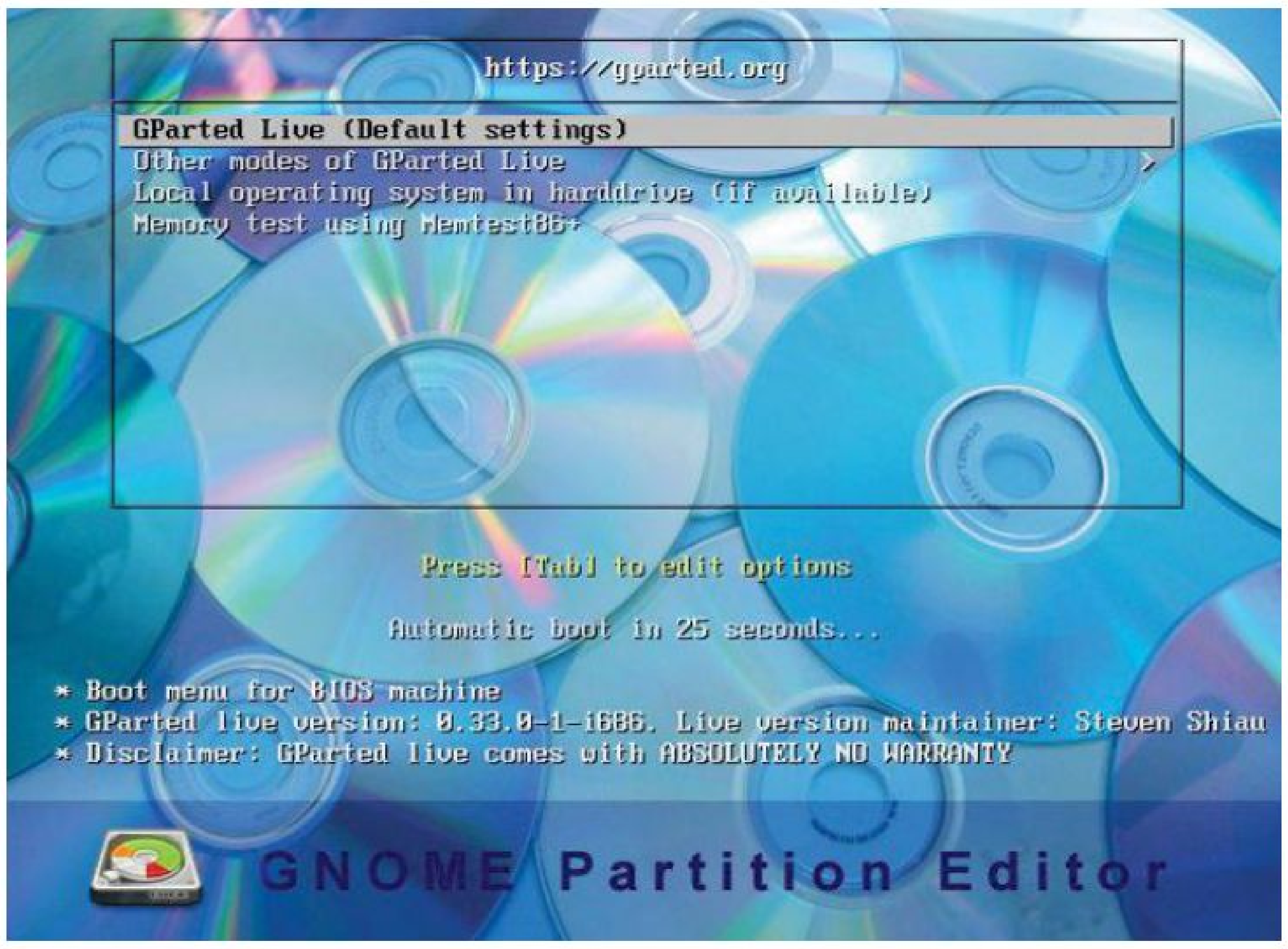
LINUX: THE ALL-IN-ONE OPTION

One of the most beautiful things about Linux, besides its inherent freeness, is that people are able to package it up with all kinds of also-free software, and send the whole thing out in one big bundle. Given that it's (usually) possible to run a Linux installation in Live form (that is, without installing it and making a mess of your precious internal drives), this can be a good way to keep those rarely used utility packages at hand, or get your hands on a whole bunch of software all at once. So, pick up some USB sticks, get these apps installed, and be ready for anything.

#1
FOR PRIVACY
TAILS
http://tails.boum.org

When you're getting all clandestine, turn to Tails. It automatically routes everything through the Tor network, keeping your online activity private, and includes a bunch of cryptographic tools to ensure all of your data is as difficult to intercept as possible. It's also handy if you want to scrub something off a drive without directly using it.
Alternately: **Whonix**



```
https://gparted.org
GParted Live (Default settings)
Other modes of GParted Live                                   >
Local operating system in harddrive (if available)
Memory test using Memtest86+

Press [Tab] to edit options

Automatic boot in 25 seconds...

* Boot menu for BIOS machine
* GParted live version: 0.33.0-1-i686. Live version maintainer: Steven Shiau
* Disclaimer: GParted live comes with ABSOLUTELY NO WARRANTY
```

Live images like GParted give you options when you load, and you can even install them alongside Windows if you're brave.

#2
FOR DRIVE MANAGEMENT
GPARTED LIVE
http://gparted.org

For messing with drive partitions or attempting to fix partition table errors, GParted is a pretty essential app—and its Linux distro incarnation keeps things very

© GPARTED.ORG

office apps: Keep it simple.
Alternately: **Typora**

7

GAME CREATION
GODOT
http://godotengine.org

While there are plenty of game engine options out there, they're often pretty demanding when it comes to eventual royalties; Godot is completely free and rapidly maturing, with Vulkan support on the way, and a huge swathe of documentation to get you started.
Alternately: **Amazon Lumberyard**

8

3D MODELING
BLENDER
http://blender.org

Blender recently ditched its game engine portion in order to focus on the features it really excels at: every step of the 3D pipeline. So, whether you're creating, sculpting, rendering, or animating, there's a tool here to help—and 17 years of maturity to back them up.
Alternately: **3D Crafter**

9

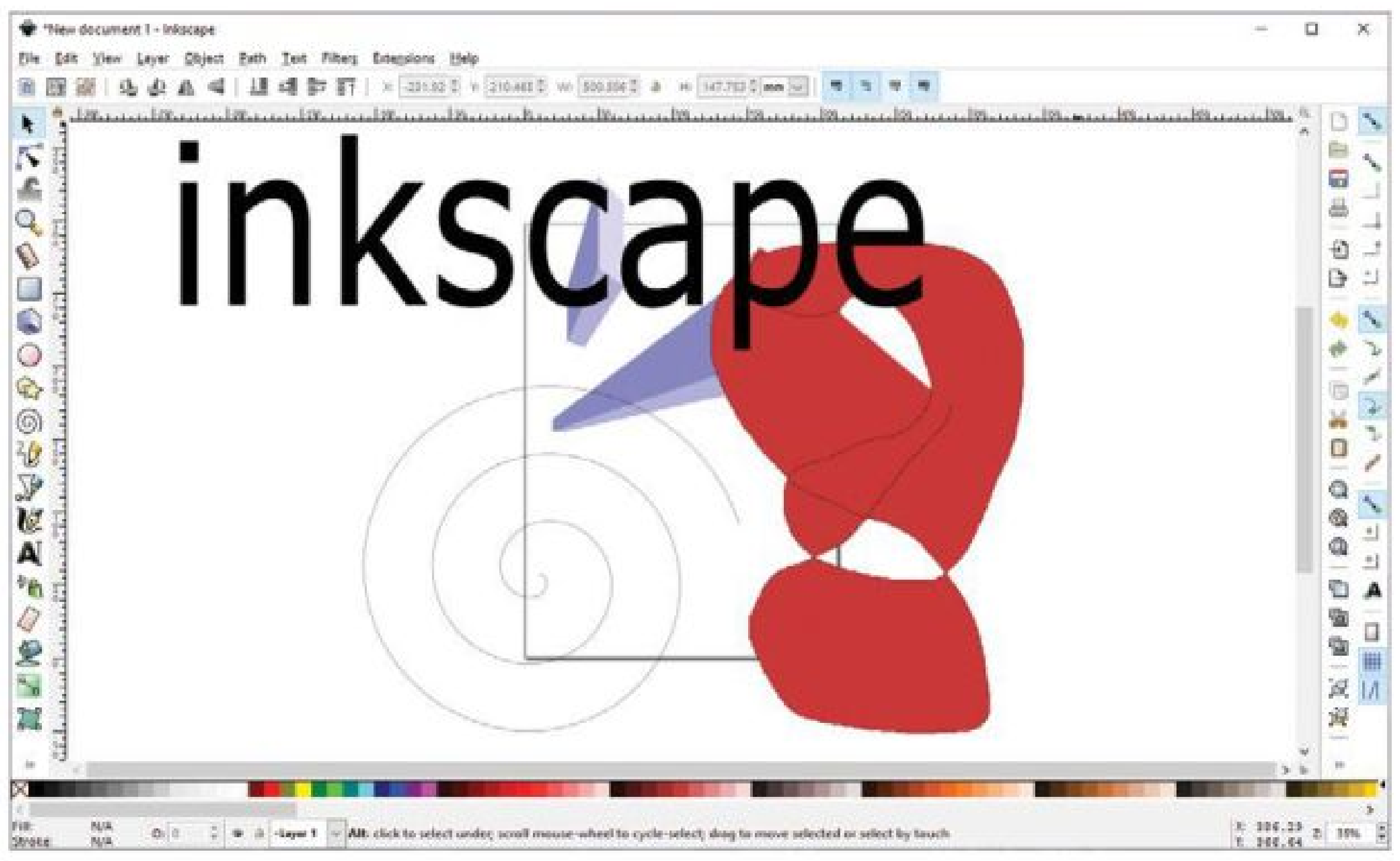
DTP
SCRIBUS
http://scribus.net

There is no sense in trying to lay out complex documents in Microsoft Word, given its propensity to tear a hole in space-time whenever you slightly resize a text box. Scribus is a much more sensible option for desktop publishing, with a powerful text engine and strong image options.
Alternately: **Lucidpress**

10

ANIMATION
SYNFIG
http://synfig.org

Whether your 2D animation needs consist of tweening vectors or skeletally animating a collection of bitmaps, Synfig gives you the necessary tools. It's adept enough to produce some professional results—although the quality of your work is down to you....
Alternately: **OpenToonz**


*New document 1 - Inkscape
File Edit View Layer Object Path Text Filters Extensions Help
inkscape

Just because you can make vector images in Inkscape doesn't mean you should.

© INKSCAPE.ORG

MEDIA

11

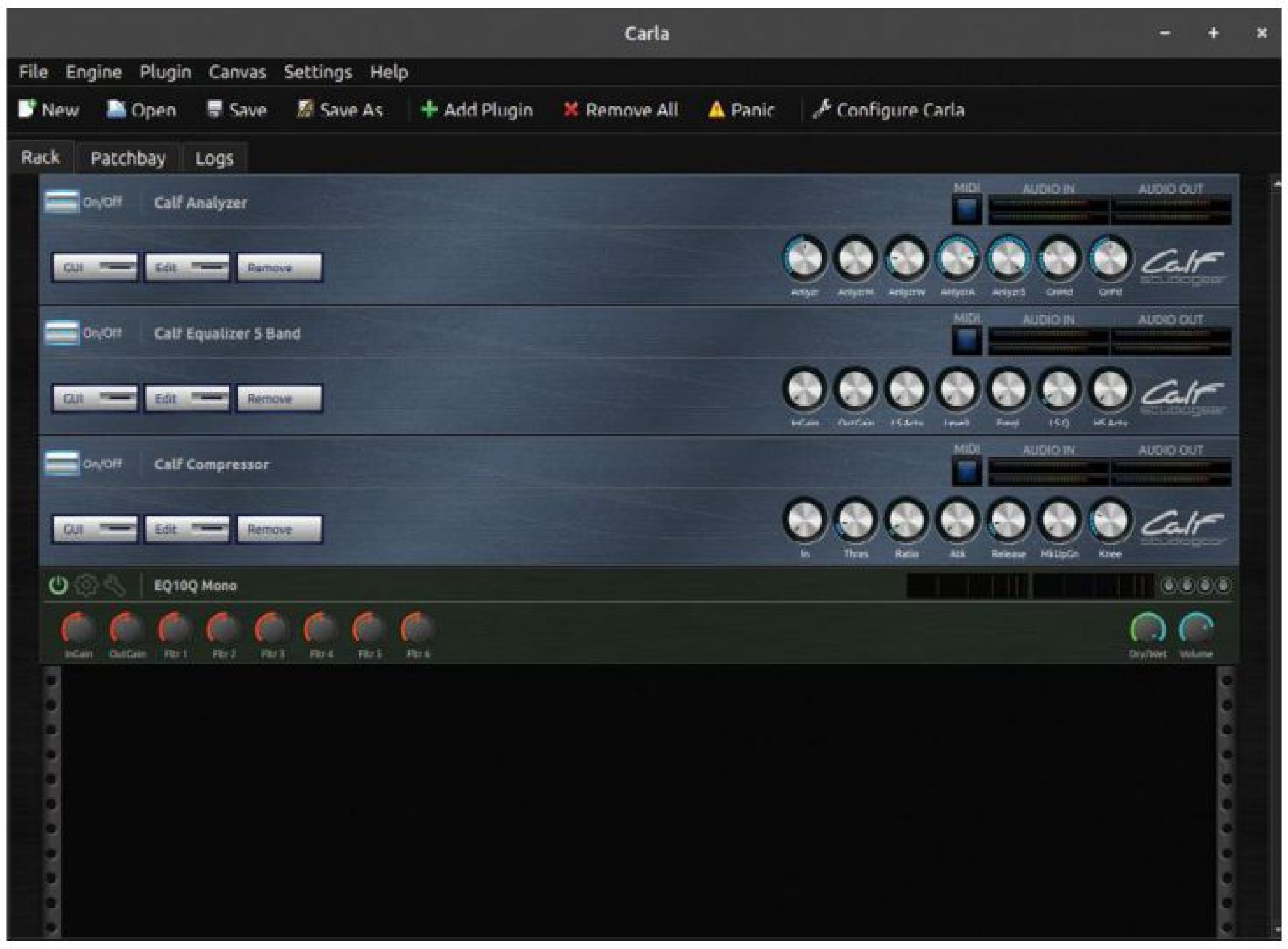
MOVIES
VLC
http://videolan.org

Other apps periodically vie for the crown, but we've never found another free player compatible with so many codecs and ready to cope with so many potential rendering glitches. Dig under the surface, and VLC can do a whole lot more—it's great for latching on to streaming services, too.
Alternately: **MPC-HC**

12

AUDIO
MUSICBEE
http://getmusicbee.com

Yes, iTunes is free. Yes, you can use iTunes if you like. But if you care about your system resources and


Carla
File Engine Plugin Canvas Settings Help
New Open Save Save As Add Plugin Remove All Panic Configure Carla
Rack Patchbay Logs
Calf Analyzer
Calf Equalizer 5 Band
Calf Compressor
EQ10Q Mono

Fancy a virtual audio rack? Ubuntu Studio can provide just that.

© UBUNTUSTUDIO.ORG

simple, packaging it with a few very straightforward but powerful file manipulation tools and little else. Perfect single-serving distro fare.
Alternately: **Clonezilla Live**

#3

FOR YOUR MEDIA CENTER
OSMC
http://osmc.tv

An unofficial mesh together of the Debian Linux distribution, noted media center app Kodi, and some custom tweaks to make its interface as usable and simple as possible, OSMC is a great distro for that living room PC—or when you want to let someone watch some films on your PC without actually giving them full access to your files.
Alternately: **LibreELEC**

#4

FOR SECURITY TESTING
KALI LINUX
http://kali.org

How tough are your computers? How bad-guy-proof is your network? Find out with Kali Linux, which carries a huge package of tools to help the white hat hacker find vulnerabilities in existing systems. You'll need to know what you're doing, and make sure you use the tools properly to avoid a worrying knock on the door, but there's none better for testing security.
Alternately: **BackBox**

#5

FOR CREATIVITY
UBUNTU STUDIO
http://ubuntustudio.org

Whether you're interested in producing video or audio, Ubuntu Studio is bursting with tools to help. Its effectiveness will, given Linux's usual awkwardness, depend on the precise hardware you have installed, but it's free. That certainly makes it worth trying before investing in expensive pro production packages.
Alternately: **AV Linux**

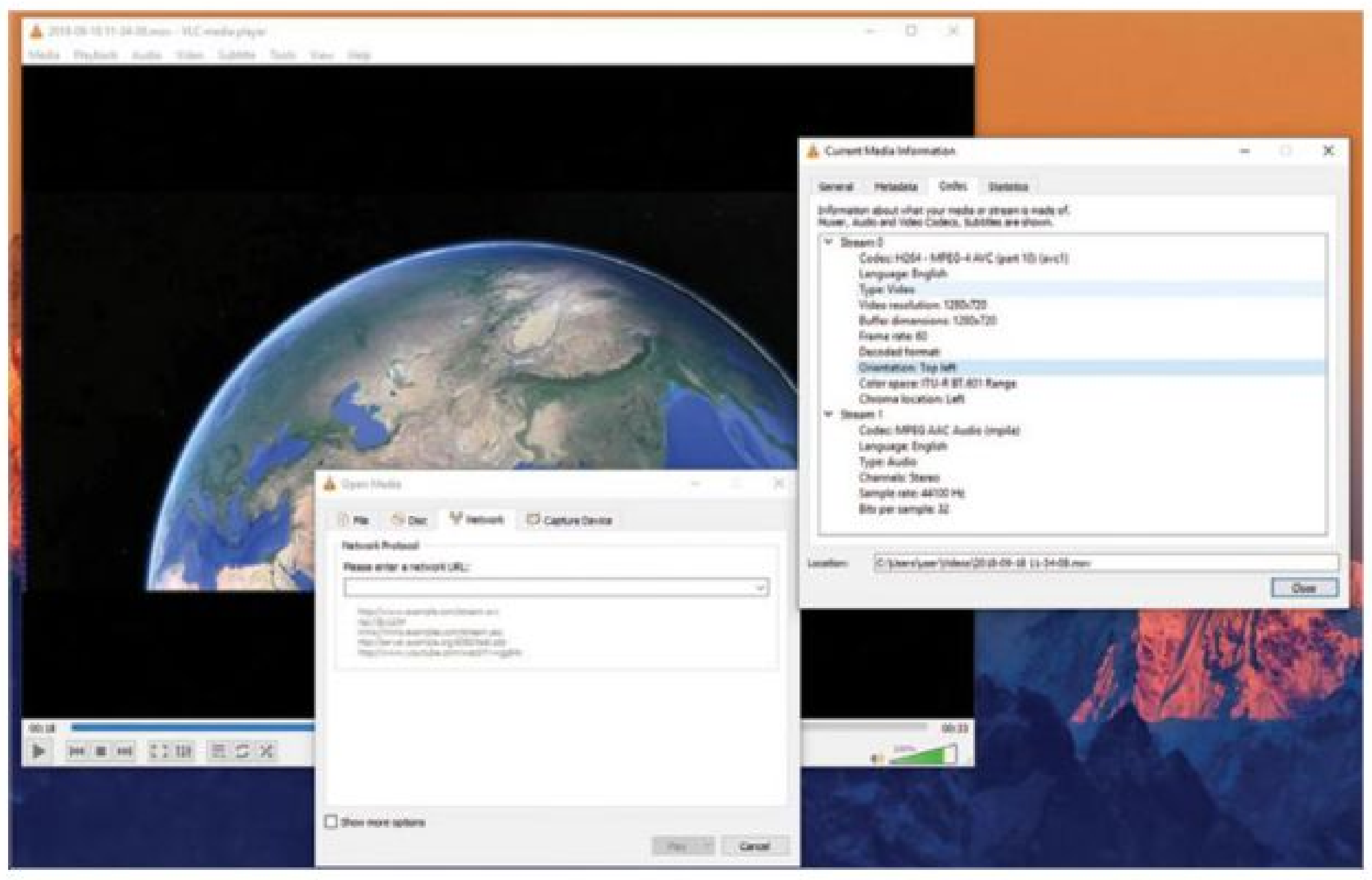
want to organize your entire music library away from Apple's sticky grasp, MusicBee is a great (and skinnable) choice.
Alternately: **Winamp**

13 LIBRARY MANAGEMENT
PLEX
http://plex.tv

For a large video collection, a large audio collection, or even a huge photo library, keeping everything easily accessible is vital. Luckily, Plex can deal with streaming all your media, and makes getting to it from outside your network an absolute breeze.
Alternately: **Kodi**

14 TRANSCODING
HANDBRAKE
http://handbrake.fr

HandBrake is a miserably ugly program. It's not easy to get started with. But once you've done the work, it's just about the most powerful video conversion tool there is—perfect for transcoding individual files or even large batches to the format you need.
Alternately: **Freemake Video Converter**



VLC includes tons of controls to alter video playback, whatever the source.

© VIDEOLAN.ORG

15 VIDEO EDITING
SHOTCUT
http://shotcut.org

Shotcut has been carving out its own niche in the video-editing world, and while it's still catching up to the big boys, it's also entirely free—no surprises, no restrictions. Unless you look on the Microsoft Store, where it's inexplicably paid-for. Don't do that.
Alternately: **OpenShot**

16 VIDEO GRADING
DAVINCI RESOLVE
http://blackmagicdesign.com

You can just as easily use Resolve for editing, but its grading and post-production effects are its real strength. It's a professional tool that's seen use in numerous Hollywood productions, and the free version is perfect for color correction, too.
Alternately: **Color Fixer Pro**

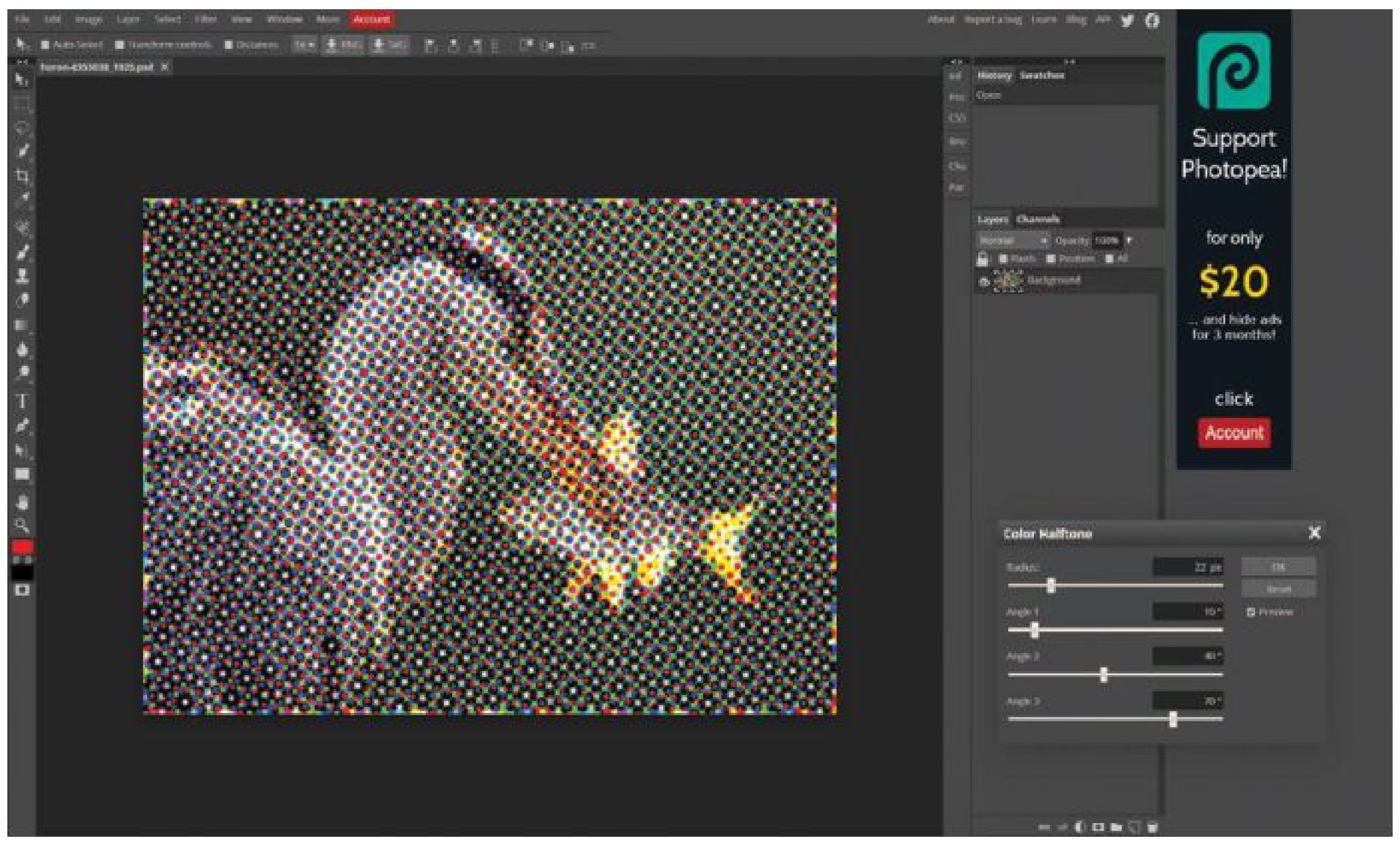
17 AUDIO EDITING
AUDACITY
http://audacityteam.org

Audacity almost annoys us: We're kinda desperate to recommend something different in this slot, but there's still nothing else that can hold a candle to it for audio cutting or tweaking. It's a tool that everyone should have installed at all times.
Alternately: **Ocenaudio**

18 PODCASTS
GROVER
Via Windows Store

Styled to look a little like Groove Music (which, we're sure, everyone is using at all times), Grover is a good way to manage podcasts if you're still doing it on your desktop. It's probably better than doing it through iTunes, at least.
Alternately: **Juice**

DO IT ONLINE

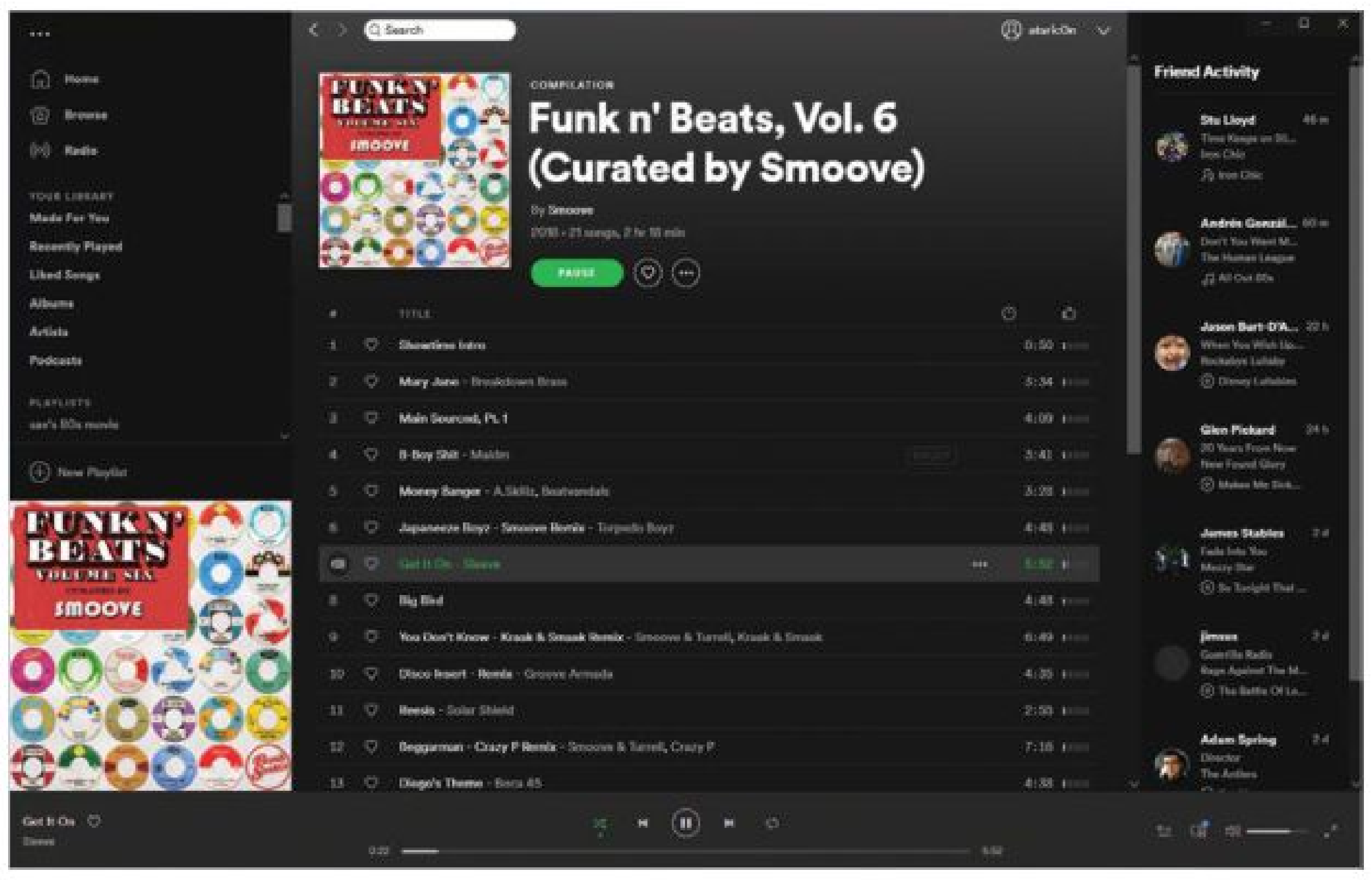


Photopea is as capable of ruining your pics as any other app.

© PHOTOPEA.COM

Fill your PC with software or take advantage of online tools? It's a tough one. In certain circumstances, this isn't an option—we don't know, for example, of an online tool that can help repartition your hard drive—but moving your work online does have a long list of advantages. Your files will theoretically always be where you left them. There's no need to manually update a piece of online software to keep it in line with the latest developments. And your local machine stays uncluttered and unslowed by the overheads of installed software. We might have presented a list of 50 programs, but we don't expect you to be mad enough to install them all.

There's an ever-growing string of online tools turning up. For the office, Google's Docs suite (http://docs.google.com) has matured to a surprising level of competence, and Microsoft's own Office Online (http://office.com) offers up a decent cut-down version of its desktop office tools, and integrates nicely with OneDrive. Want to edit photos? Photopea (http://photopea.com) is a Photoshop-esque image editor that, in some cases, even manages to do more than the software it's emulating—we even recommend it over GIMP, given that Photopea doesn't include "randomly crashing" among its list of hobbies. Many of the desktop tools that made our list also have an online component, and in some cases it's preferable over its installed counterpart. LastPass is best managed online, TeamViewer works great through its Chrome plugin, Spotify's web interface is a little stronger than its desktop version, and you can employ the services of http://userstyles.org to mess with the CSS and customize it to your liking. Basically, make your own decision: If you don't want to install something, check out its website and look for an online component.



19

AUDIO STREAMING

SPOTIFY

http://spotify.com

You are spoiled for choice in the streaming market, but (despite its oppressive ads) Spotify's massive library and straightforward interface makes it our top choice—though the free tier forces you to listen to your playlists on shuffle.
Alternately: **Deezer**

There's no music and podcast library quite as big or convenient as Spotify's.

20

ORGANIZATION

THE RENAMER

http://therenamer.com

You've got lots of files. Videos, music, all from legitimate sources—but there's no consistency in naming or storage. Sort them out without the effort using The Renamer, which does exactly what you think it does.
Alternately: **Bulk Rename Utility**

WORKING

TeamViewer's cross-platform abilities mean you can use it to control any other computer, even Macs.

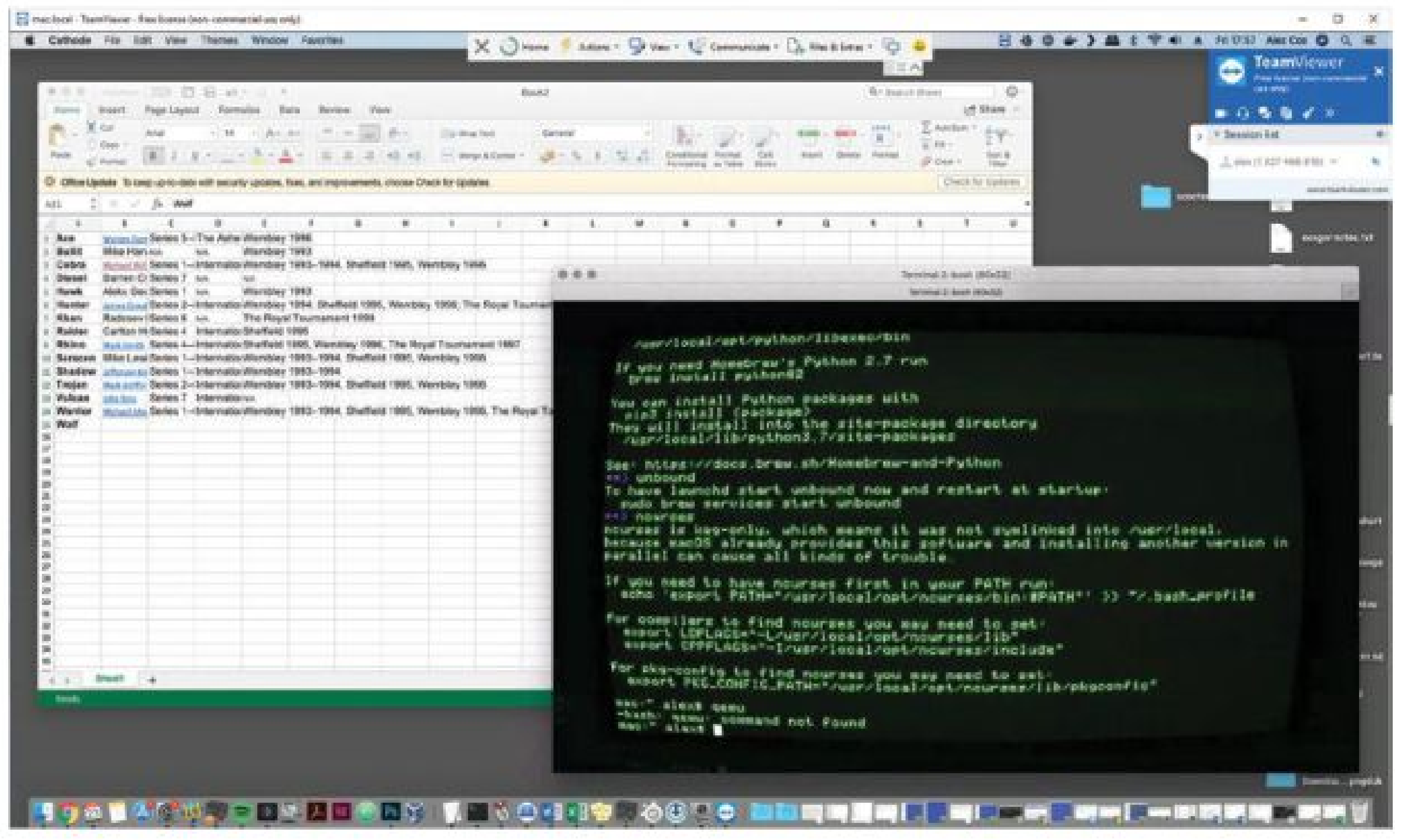
21

OFFICE

LIBREOFFICE

http://libreoffice.org

Pretty much a free equivalent to Microsoft Office, and compatible with the same file formats, LibreOffice is a non-paid essential. It even does more: There's a full database and a complex formula editor included.
Alternately: **Apache OpenOffice**



```
  /usr/local/opt/python/libexec/bin

If you need Homebrew's Python 2.7 run
  brew install python@2

You can install Python packages with
  pip3 install <package>
They will install into the site-package directory
  /usr/local/lib/python3.7/site-packages

See: https://docs.brew.sh/Homebrew-and-Python
==> unbound
To have launchd start unbound now and restart at startup:
  sudo brew services start unbound
==> ncurses
ncurses is keg-only, which means it was not symlinked into /usr/local,
because macOS already provides this software and installing another version in
parallel can cause all kinds of trouble.

If you need to have ncurses first in your PATH run:
  echo 'export PATH="/usr/local/opt/ncurses/bin:$PATH"' >> ~/.bash_profile

For compilers to find ncurses you may need to set:
  export LDFLAGS="-L/usr/local/opt/ncurses/lib"
  export CPPFLAGS="-I/usr/local/opt/ncurses/include"

For pkg-config to find ncurses you may need to set:
  export PKG_CONFIG_PATH="/usr/local/opt/ncurses/lib/pkgconfig"

mac:~ alex$ qemu
-bash: qemu: command not found
mac:~ alex$ 
```

22

PDF VIEWER

FOXIT READER

http://foxit software.com

Foxit's big selling points are its connected features, which tell you when a PDF has been scribbled on or tweaked, but we're backing it for its ability to open PDFs quickly without eating all of our system resources. That's not a big ask.
Alternately: **Adobe Reader**

23

EMAIL

eM CLIENT

http://emclient.com

While many of us manage our mail on the web these days, eM Client's free tier allows you to take desktop control of two accounts. It's fully compatible with the more complex features of Outlook and Gmail accounts, and super-easy to use.
Alternately: **Thunderbird**

24

SOCIAL

HOOTSUITE

http://hootsuite.com

Dig through the pricey corporate options and find Hootsuite's three-account free plan: You can schedule posts, manage multiple social services, and see your searches in their own live-updating columns. It's social taken to the next level.
Alternately: **TweetDeck**

25

COMMUNICATING

FRANZ

http://meetfranz.com

It's tough being connected. There's the family WhatsApp, the work Slack, the gaming Discord, that one guy who won't stop using ICQ for some reason. No problem: Mash them all together using Franz. You can even take your combined account between computers.
Alternately: **Pidgin**

26

TO-DO

MICROSOFT TO-DO

Via Windows Store

Microsoft's app is a superb way to list the things you're procrastinating on, the things you haven't quite done yet, and the things you won't do in a million years. Maybe, just maybe, you'll be able to check one off.
Alternately: **Wunderlist**

27

VPN

PROTONVPN

http://protonvpn.com

VPNs are essential. Problem is, the free VPN market is hampered by bandwidth restrictions. Not so with ProtonVPN—you can use its free version as much as you like; the annoyance is transferred to a speed limit instead.
Alternately: **Hotspot Shield**

28

REMOTE DESKTOP

TEAMVIEWER

http://teamviewer.com

How often have you tried to diagnose a technical problem over the phone and ended up bashing your head on your keyboard? No more. TeamViewer is easy to set up, super-secure, and can give you direct access to your desktop (or an elderly relative's) via a browser.
Alternately: **TightVNC**

29

NOTES

NOTEPAD++

http://notepad-plus-plus.org

There's a whole lot of contextual formatting in Notepad++ (it is, after all, made for sketching code in all manner of languages), but it's just as much a straightforward and capable alternative to Microsoft's Notepad. And that's a good thing.
Alternately: **Atom**

30

PLANNING

TRELLO

http://trello.com

Got a big project coming up? Put it on virtual notecards, pin it up on a virtual board, and spread those tasks out between everyone who you've roped in to help. Hopefully, they'll actually chip in, rather than just being virtually present.
Alternately: **Evernote**

© TEAMVIEWER.COM © SPOTIFY.COM

FILES

31

UNDELETING
RECUVA
http://ccleaner.com/recuva

No guarantees, but if there's a file that's gone to the big data graveyard in the sky, you may be able to convince it back to life with Recuva. Generally, deleting only removes the reference to the file, not the file itself: Recuva finds what's left behind.
Alternately: **Undelete 360**

32

DISK RESCUE
TESTDISK
http://cgsecurity.org

Whole drive letting you down? Mechanical disk giving you the click of death? TestDisk can ignore all the usual safeguards and filesystems in order to wade through the raw data, sector by sector, giving you one last chance to rescue your files.
Alternately: **Paragon Rescue Kit**

33

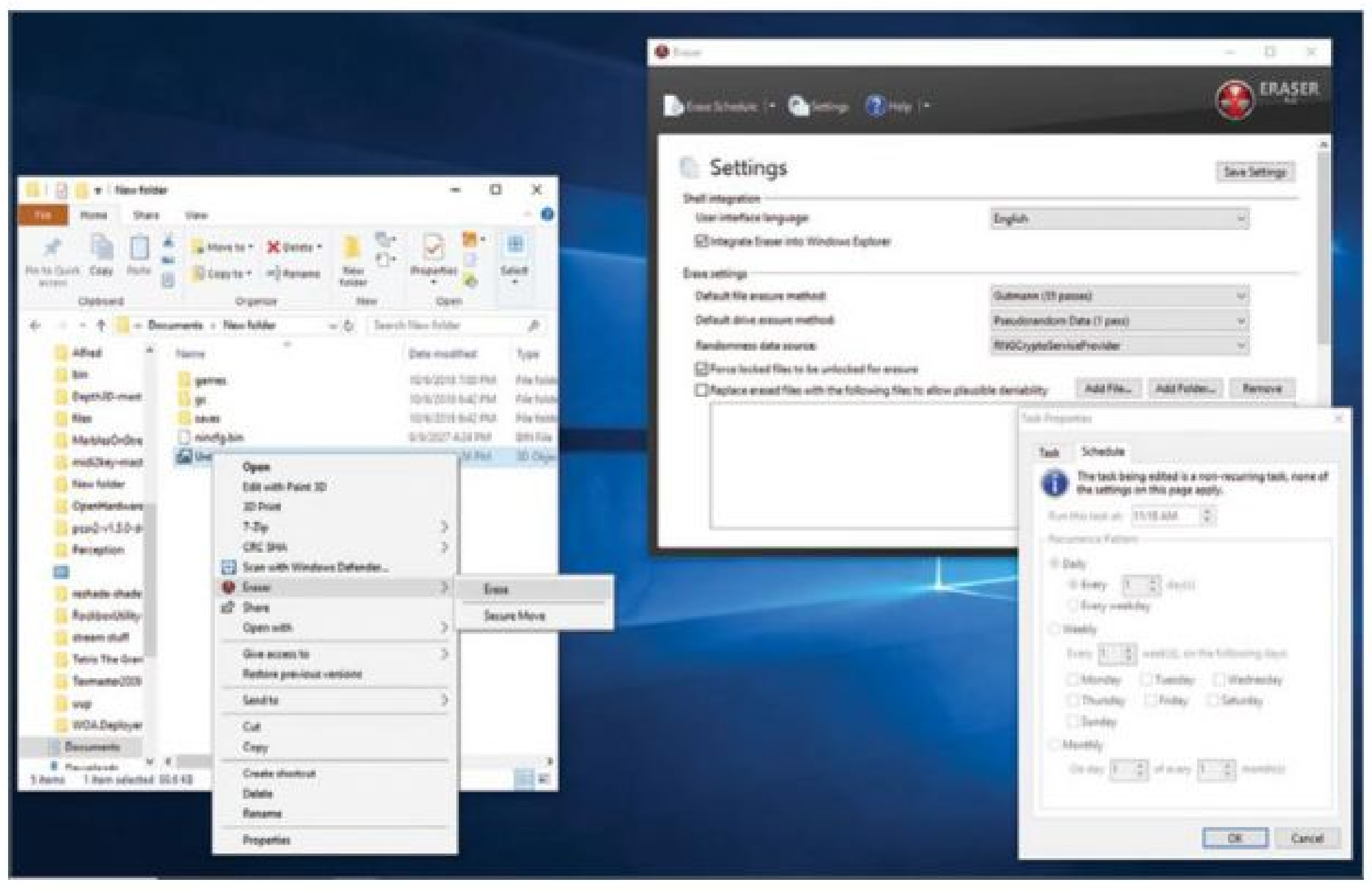
DESTRUCTION
ERASER
http://eraser.heidi.ie

As Recuva and TestDisk prove, deleting something won't keep it from the determined data sniffer. Eraser is the equivalent of a cross-cut shredder, securely overwriting files (or an entire drive) with your choice of destruction standard.
Alternately: **BleachBit**

34

MOVEMENT
TERACOPY
http://codesector.com

Windows' copying procedures can leave a lot to be desired; if you're shuffling files from place to place, TeraCopy (which uses advanced buffering techniques) can do the job a lot faster and much more reliably.
Alternately: **Ultracopier**



Need those files gone for good? Fill a folder and set Eraser on them.

© ERASER.HEIDI.IE

35

MANAGEMENT
MULTI COMMANDER
http://multicommander.com

Whether you come from the era when it was popular or not, the Norton Commander-style two-pane file management of Multi Commander is a natural and highly efficient way to move files and folders from one place to the other.
Alternately: **FreeCommander**

36

ARCHIVING
7-ZIP
http://7-zip.org

Do away with that 2,000-day expired shareware version of WinRar: 7-Zip supports way more than just .7z archives, and it's free. Whether compressing or decompressing files, it's an essential component of any good Windows install.
Alternately: **IZArc**

37

PREVIEWING
XnVIEW MP
http://xnview.com

XnView MP is a great way to preview images, taking you beyond the "extra large icons" school of picture glimpsing to a quickly browsable and logical graphical interface—you can use it for batch processing or conversion, too.
Alternately: **IrfanView**

38

EXPLORING
TABLACUS
http://tablacus.github.io

Quite why Windows Explorer doesn't have tabs in 2019 we don't know, but Tablacus solves that problem: It's a file manager that, yes, includes tabs. It also lets you tile folders in panes, and disable any components you don't need.
Alternately: **XYplorer**

39

CLOUD STORAGE
ONEDRIVE
http://onedrive.com

The integration of Microsoft's cloud platform with Windows makes it a top choice merely for ease of use—there's basically nothing to set up. It may not have the largest capacity, but where other integrations falter, OneDrive will be standing tall.
Alternately: **Mega**

40

UNINSTALLING
IOBIT UNINSTALLER
http://iobit.com

Oh, sure, Windows can uninstall software. But how thorough is it? Does it hunt through your drive to find every associated file? Does it fully scrape that space clean? IObit's neat program ensures that removed apps are actually removed the right way.
Alternately: **Geek Uninstaller**

SECURITY

41

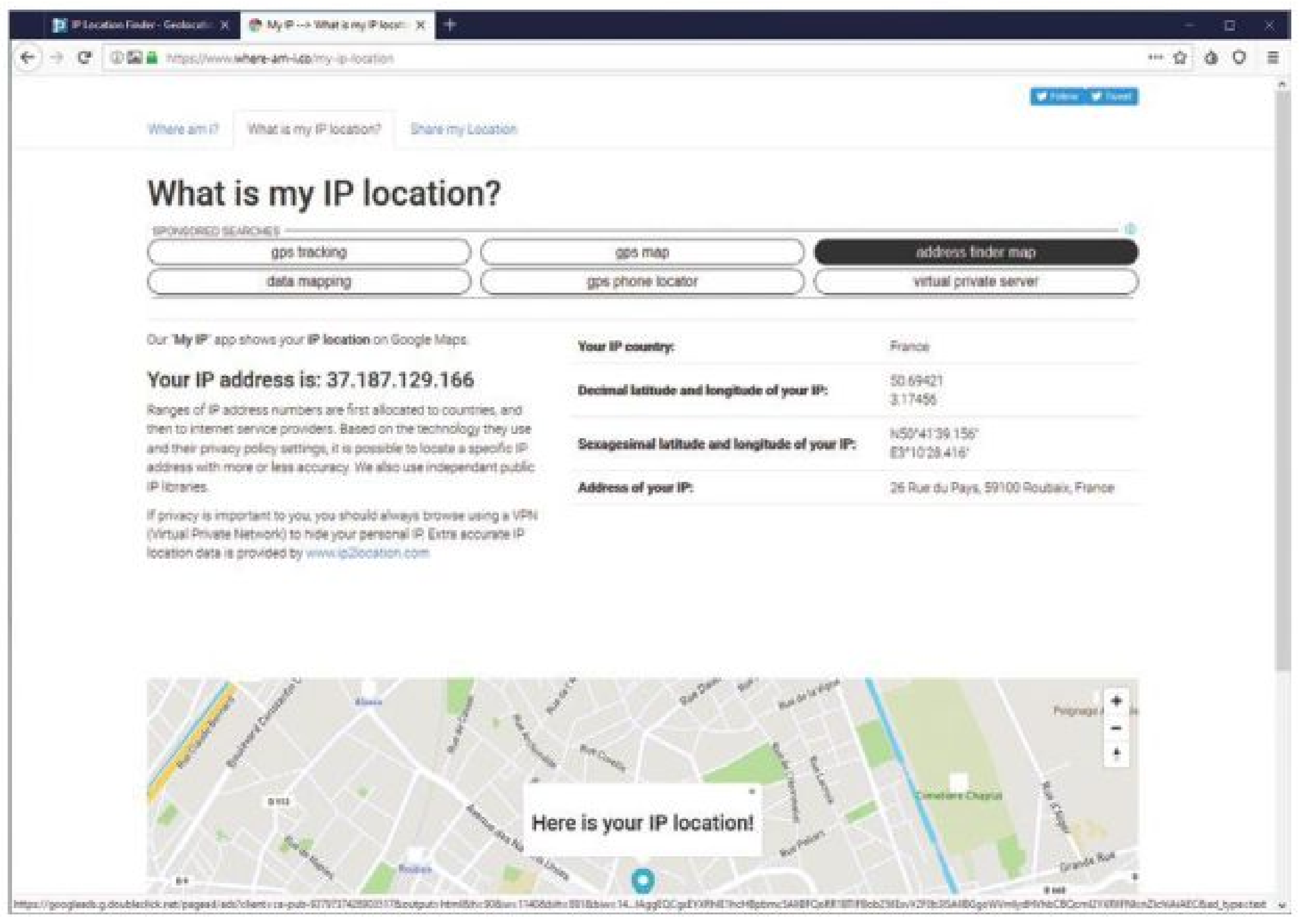
BACKUP
COBIAN BACKUP
http://cobiansoft.com

Cobian Backup is one of the most capable free backup packages there is. Send your files off to an external drive, send them to a network location, send them to an FTP server: whatever works.
Alternately: **EaseUS Todo Backup**

42

PASSWORD MANAGEMENT
LASTPASS
http://lastpass.com

There are plenty of solutions for managing your precious passwords, but LastPass wins points for the generosity of its free offering—there are a few desirable features as part of its paid offering, but nothing essential.
Alternately: **Dashlane**



What is my IP location?

Our 'My IP' app shows your **IP location** on Google Maps.

Your IP address is: 37.187.129.166

Ranges of IP address numbers are first allocated to countries, and then to internet service providers. Based on the technology they use and their privacy policy settings, it is possible to locate a specific IP address with more or less accuracy. We also use independant public IP libraries.

If privacy is important to you, you should always browse using a VPN (Virtual Private Network) to hide your personal IP. Extra accurate IP location data is provided by www.ip2location.com

Your IP country:	France
Decimal latitude and longitude of your IP:	50.69421 3.17456
Sexagesimal latitude and longitude of your IP:	N50°41'39.156' E3°10'28.416'
Address of your IP:	26 Rue du Pays, 59100 Roubaix, France

Where in the world are you? With Tor Browser, that answer changes every time you visit a new site.

© TORPROJECT.ORG

43

SYSTEM CLEAN-UP

CCLEANER

http://ccleaner.com

CCleaner does all those long, laborious clean-up tasks in one place. You can either run a selective scrubbing job, or set up a batch job to deal with everything at once. Just be wary of the pop-ups.
Alternately: **Advanced System Optimizer**

44

ANTIVIRUS

BITDEFENDER FREE EDITION

http://bitdefender.com

Many free antivirus packages are not worth the drive space they're written on. Bitdefender is: It's not too heavy on the hassle, includes a quality AV engine with frequent updates, and a slick interface.
Alternately: **Windows Defender**

45

POST-INFECTION

SPYBOT SEARCH & DESTROY

http://safer-networking.org

Install pre-emptively: If you suspect something untoward is on your system, Spybot is likely to be able to hunt it down and exterminate it.
Alternately: **Malwarebytes**

46

ENCRYPTION

BOXCRYPTOR

http://boxcryptor.com

Do you trust your cloud storage provider? Enough to store your most personal files online without obfuscation? Probably not. But with Boxcryptor, you can construct an encrypted storage area—and if the provider encrypts, it's double safe.
Alternately: **VeraCrypt**

47

INTERNET PRIVACY

TOR BROWSER

http://torproject.org

Routing your Internet traffic via Tor makes you very difficult to track, and helps you resist online fingerprinting. The Tor browser makes doing so incredibly easy.
Alternately: **Iridium Browser**

48

NETWORK MONITORING

AXENCE NETTOOLS

http://axence.net

A full suite of 10 network tools, from monitoring to scanning to tracing routes. There's even a little cheeky internal Windows tomfoolery, all spun off from Axence's pro-level IT management suite.
Alternately: **PRTG Network Monitor**

49

NETWORK TROUBLESHOOTING

WIRESHARK

http://wireshark.org

A bit heavyweight, but Wireshark does its job so well that we have to recommend it. If you want to know what's going on with your network and why a function won't play ball, it's the most accomplished protocol analyzer around.
Alternately: **Colasoft Capsa**

50

FIREWALL

TINYWALL

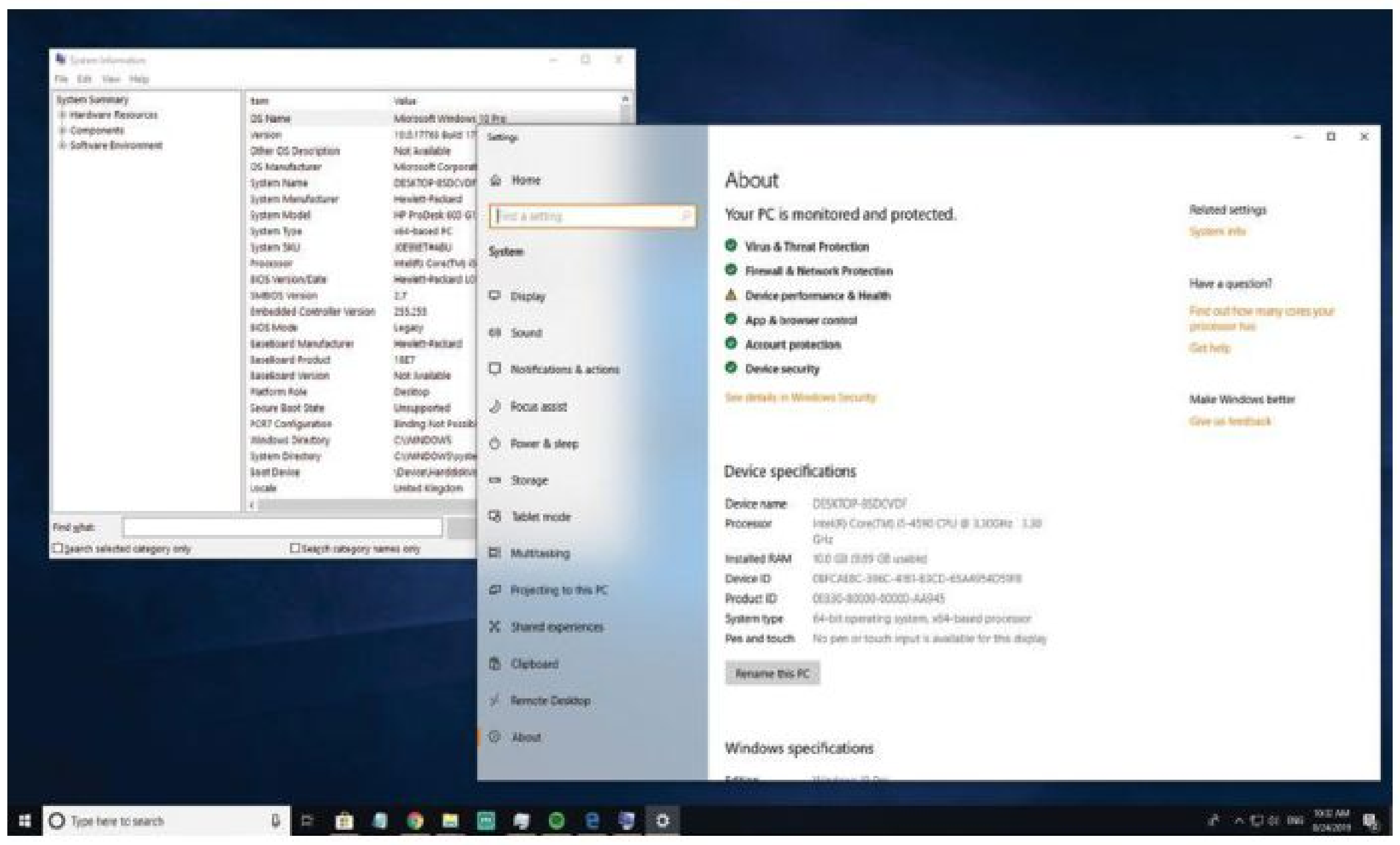
http://tinywall.pados.hu

Don't rely on your router, or even Windows, to do the job of batting back misbehaving packets, or stopping snoopers from probing your ports. TinyWall is super-lightweight and makes for a useful additional line of defense.
Alternately: **ZoneAlarm Free** ⏻

DON'T CHEAP OUT

Hear us out as we use this box in an article about free apps to tell you not to use them: Sometimes it pays to pay. Sometimes a free package can't do the exact thing you want—if you're interacting with a business with very precise standards, a document that, say, LibreOffice produces might have subtle differences that make it look terrible on that company's Microsoft Office-packing machines. An open-source package comes with no guarantees, no support, no comeback if everything goes wrong. It might have a forum full of enthusiastic amateurs and some official-looking documentation, but it doesn't have any guarantee of professionalism. If it's mission critical, don't rely on free software.

Often, free apps either lack critical features (many exist simply to tease a paid upgrade) or can't keep up with the quality of their paid-for alternatives. For instance, while we've recommended ShotCut as a free video editor, it is nowhere near as complex or well built as something like Adobe Premiere. Even Cakewalk, our pick for free audio recording and editing and a formerly paid-for app, isn't the best choice in its sector because it's a little behind the curve. Then there's the niche apps for which there is no free alternative, and you should also consider Windows itself—while we put our weight behind experimenting with Linux, it is not, for most, a production OS. Windows is rock solid, compatible with just about everything, has a huge software library, and despite the fact that you can run it in a chopped-down unactivated mode, you really should pay for the license, or at least attempt to transfer an old Win 7 license up the chain.



Windows is worth the cash, unless you're truly ready for Linux.

© MICROSOFT

HOW TO FIGHT RANSOMWARE

JONNI BIDWELL KNOWS HOW NOT TO PAY RANSOMS AND HOW NOT TO BE FOOLED BY SOCIAL ENGINEERING SCAMS…

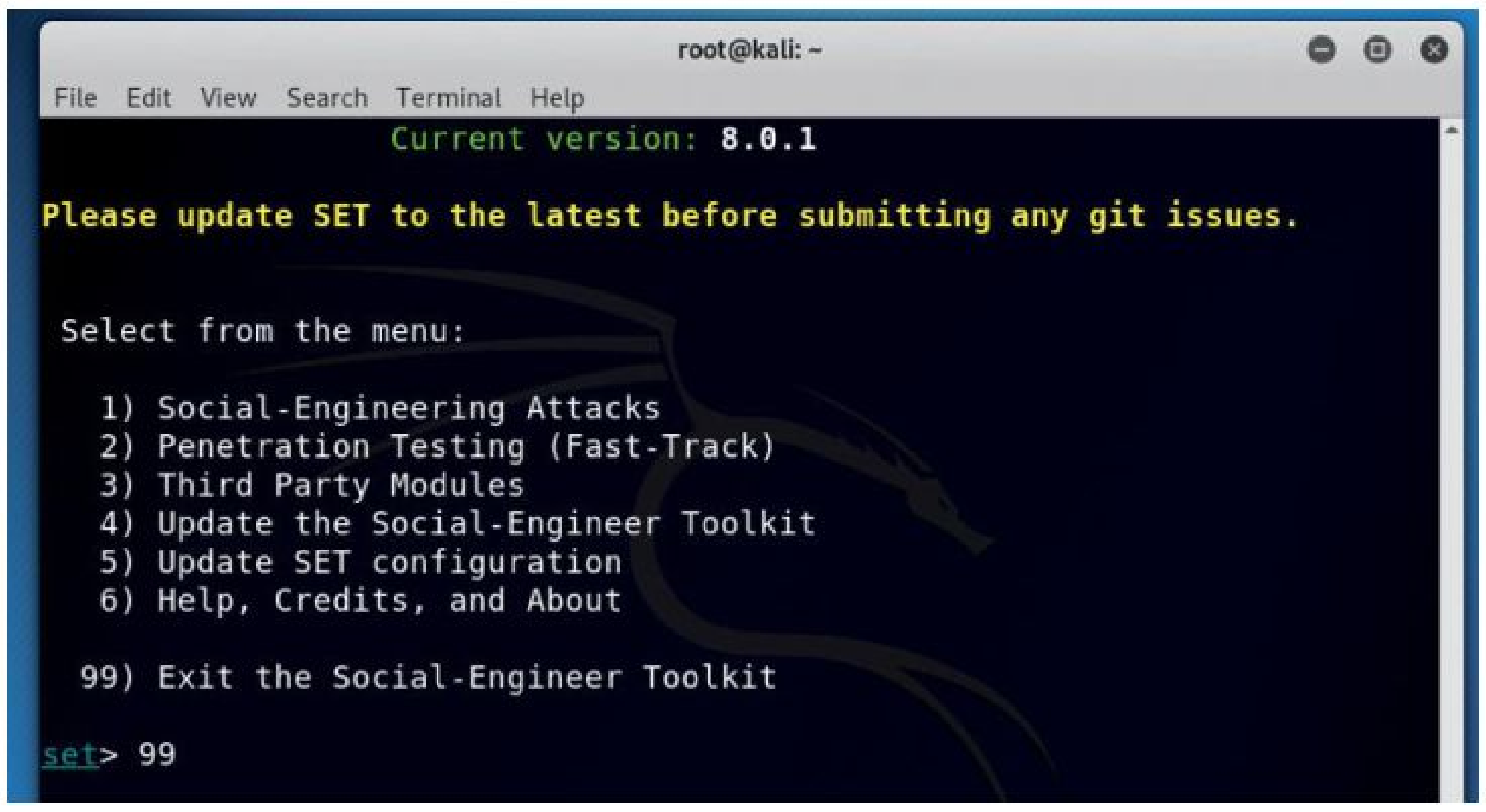
RANSOM AND DECEIT

SCAMMERS KNOW THAT YOUR DATA IS MORE VALUABLE TO YOU THAN TO OTHERS—DON'T LET THEM EXPLOIT THIS FACT

Holding things to ransom is an ancient idea, and one that has worked very well. Likewise using smooth talking to hoodwink people into doing things they probably shouldn't. But in the digital age, these practices take on a whole new, sinister dimension. On the face of it, having files held to ransom is in an entirely different league to having a family member kidnapped. But what if people's lives depended on the integrity of those files? This has happened on more than one occasion.

The WannaCry ransomware outbreak of 2017 infected some 300,000 computers in 150 countries, making it, according to veteran security researcher Mikko Hypponen, "the biggest ransomware outbreak in history." People showing up to work were greeted by their computers asking for bitcoin payments equivalent to $300–$600 to decrypt their files. In the UK, it brought the National Health Service (NHS) to its knees.

Commentators were quick to point out that the NHS had, and still has, a number of machines running Windows XP, but these weren't really the problem—most were embedded installations that can't be upgraded and weren't connected to the network. The problem was the huge number of unpatched Windows 7/8/2000 systems that were vulnerable to a bug in the SMB protocol, of which, it turns out, the NSA was aware for some time. It had, in fact, weaponized said bug for use in its own Tailored Access Operations unit, and named the exploit EternalBlue.



```
                    Current version: 8.0.1

Please update SET to the latest before submitting any git issues.


 Select from the menu:

   1) Social-Engineering Attacks
   2) Penetration Testing (Fast-Track)
   3) Third Party Modules
   4) Update the Social-Engineer Toolkit
   5) Update SET configuration
   6) Help, Credits, and About

  99) Exit the Social-Engineer Toolkit

set> 99
```

SET, the Social Engineering Toolkit, comes with Kali Linux and is full of tips and tricks (and references to our favorite movie).

© KALI LINUX

That exploit fell into the hands of a hacker collective known as the Shadow Brokers. The NSA alerted Microsoft, and a patch was issued in March 2017. In April 2017, EternalBlue—alongside other NSA exploits named EternalChampion and EternalRomance—was leaked by the Shadow Brokers, and a month later, WannaCry used it to wreak havoc. See the box on page 35 for more.

We'd love to say there are magic tools that can help you recover from any ransomware attack, but that's not the case. There are a couple of things that are guaranteed to help, though, so read on....

PAY UP OR THE DATA GETS IT

A number of high-profile organizations have paid ransom fees, and we're likely to see a lot more of this unless our collective security game is upped. Large organizations with lax security practices can be crippled by a careless employee falling for an email scam. This may be an untargeted attack, where the ransomware keymasters' expected targets are unsuspecting home users, in which case the asking price is pretty modest. Or it could be some kind of spear phishing campaign, where execs or sysadmins are targeted so their privileges or well-endowed bank accounts can be ransacked. And if you're going to cripple a large organization, you'll probably be after more than pocket change.

In June this year, Riviera Beach City Council in Florida agreed to pay a $600,000 (65 BTC) ransom to hackers after its systems were crippled. It joins a growing number of institutions that have chosen to cough up six-figure sums to restore critical services. A 2018 report from SentinalOne surveyed 500 large organizations and found that of those hit by ransomware, 45 percent of them paid up, but only 26 percent of those had their files unlocked.

BACK UP YOUR FILES

THEY SAY THERE ARE TWO KINDS OF PEOPLE: THOSE WHO DON'T BACK UP THEIR FILES, AND THOSE WHO HAVE NEVER EXPERIENCED DATA LOSS

For typical home use, your personal files are, we think, much more important than the rest of the system. If your system gets hosed you can re-install it and all the apps in minutes. Your photos, documents, and movies are far more precious.

You may, and should, already back up some of these to some kind of cloud storage. The trouble with clients that automatically keep your local and cloud files synchronized is that in the midst of a ransomware attack, they will happily send scrambled files to the cloud. So, instead of having an off-site backup, you effectively have an off-site trash can.

It depends on the nature of the ransomware, though—perhaps it changes file names, or perhaps the malware interferes with the client and prevents the sync from happening, in which case you'd be OK. Still, why take the risk? Use a proper backup tool, and back up to an external drive that isn't always connected. Backing up for the first time might give you some sense of security, but backing up should be a way of life, not a one-off event, or something you do on an ad hoc basis. Unless you integrate it into your digital routine, you're risking all your latest and greatest work. Fortunately, thanks to modern tools, this is easier than ever.

Of course, life will be much easier if your files are in some kind of ordered state, but we can't all be Melvil Dewey. Your first backup may take a long time. Or you may have to cancel it when you realize certain directories should have been included or excluded. But once it's done, you're happy with it, and don't go messing up your document structure too much, subsequent backups will be much easier and quicker, as they're done incrementally—only files that have changed since the last backup will be stored.

ANATOMY OF A RANSOMWARE ATTACK

EVER WONDERED HOW ALL THIS HIGH-TECH FINANCIAL STEALING AND DATA SCRAMBLING WORKS? WONDER NO MORE...

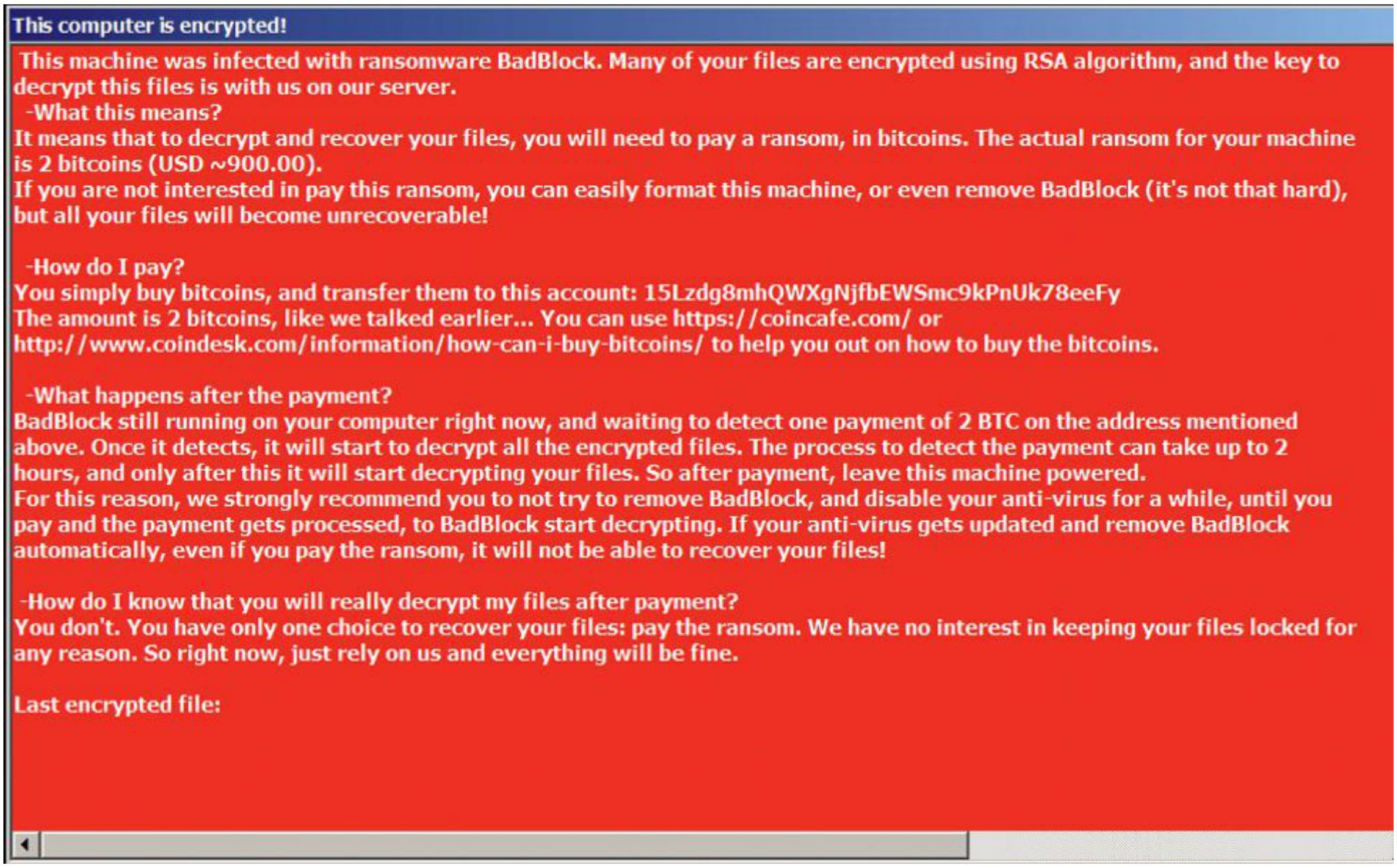
Unfortunately, if you fall victim to a ransomware attack and don't have any backups, it's probably too late to do anything about it. The usual asking price to unlock is around $500, though many variants threaten to increase this after a couple of days, and may threaten to make decryption impossible after longer. These threats just provoke anxiety in the victim, who's more likely to pay up before considering the merits of doing so.

What is important to remember is that while there's a possibility that whoever's in control of this malware is reasonable enough to provide a decryption key, there's also the possibility that they won't. Their business model, after all, is to collect payments, so why should they bother with the extra admin of sending an email after that is achieved? It's not like people who receive a key will recommend that particular strain of malware to their friends. Be that as it may, whether or not you have access to it, a decryption key probably does exist somewhere. There is, of course, malware that just deletes everything—this class of malware is known as a wiper, and would fall into the Chaotic Evil category in D&D—but it doesn't offer criminals much in the way of revenue generation. Since crypto is hard, the people peddling ransomware often get it wrong, and it is possible to recover a decryption key without becoming a victim of extortion. To understand how this is possible, it's necessary to understand how all this key generation malarkey works.

Traditional symmetric encryption relies on two people being able to agree on a secret key by a secure channel. That channel might be a meeting in the woods, or sealed message delivered by a trusted intermediary. Today's numerous, distant electronic transactions do not allow us this luxury. We can't go whisper to our buddy at PayPal every time we want to pay for something online; every transaction requires a new key to be negotiated.

Fortunately, we now have public key (asymmetric) encryption, which enables us to negotiate a shared secret with a remote party, be it a person or a machine, even if we've never met them. This is what underlies the key-exchange part of SSL/TLS (used in HTTPS), SSH, and PGP communications. Public key crypto is also intrinsic to the workings of all cryptocurrencies. It's a fascinating subject, and also a strange concept to get your head around, but we'll leave you to ponder it at your leisure. All you need to know is that it requires parties to hold not one but two keys—a keypair—only one of them needs to be kept secret, and random numbers are involved.

Ransomware that phones home to some central server could use symmetric encryption to perform its sordid garbling. A



This machine was infected with ransomware BadBlock. Many of your files are encrypted using RSA algorithm, and the key to decrypt this files is with us on our server.

-What this means?

It means that to decrypt and recover your files, you will need to pay a ransom, in bitcoins. The actual ransom for your machine is 2 bitcoins (USD ~900.00).

If you are not interested in pay this ransom, you can easily format this machine, or even remove BadBlock (it's not that hard), but all your files will become unrecoverable!

-How do I pay?

You simply buy bitcoins, and transfer them to this account: 15Lzdg8mhQWXgNjfbEWSmc9kPnUk78eeFy

The amount is 2 bitcoins, like we talked earlier... You can use https://coincafe.com/ or http://www.coindesk.com/information/how-can-i-buy-bitcoins/ to help you out on how to buy the bitcoins.

-What happens after the payment?

BadBlock still running on your computer right now, and waiting to detect one payment of 2 BTC on the address mentioned above. Once it detects, it will start to decrypt all the encrypted files. The process to detect the payment can take up to 2 hours, and only after this it will start decrypting your files. So after payment, leave this machine powered.

For this reason, we strongly recommend you to not try to remove BadBlock, and disable your anti-virus for a while, until you pay and the payment gets processed, to BadBlock start decrypting. If your anti-virus gets updated and remove BadBlock automatically, even if you pay the ransom, it will not be able to recover your files!

-How do I know that you will really decrypt my files after payment?

You don't. You have only one choice to recover your files: pay the ransom. We have no interest in keeping your files locked for any reason. So right now, just rely on us and everything will be fine.

Last encrypted file:

You're unlikely to see a screen like this on Linux, or such a high ransom demand—but you never know.

© LINUX

random key and a unique identifier could be generated on the target machine, and both of these numbers sent and then stored on that command and control (CC) server. All traces of the key would be removed from the victim's machine once files had been duly scrambled, and the unsuspecting victim would then send the requested ransom, together with their unique identifier to the extortionist.

Said extortionist, if they had any shred of decency, would then provide the decryption key, and life would go on. This all relies on some degree of centralization: Somewhere, a list of keys and tokens needs to be stored. For large-scale attacks, this isn't ideal—often, multiple command and control servers are used for redundancy—and it makes more sense to somehow store those keys locally. Without public-key encryption, this turns into a Catch-22 cascade of futility. You can encrypt the key and store it locally, but where do you store the key used to encrypt that key?

Instead, an attacker can use a hybrid scheme whereby the symmetric key (or keys) used to scramble all the files is stored on the victim's machine, but encrypted asymmetrically. The simplest implementation of this type of scheme would require our attacker to only look after a single private key, while the public key could be stored locally—inside the decryption program, for example.

So, in order to recover their files, the victim needs to pay the ransom, which releases the attacker's private key, which is combined with the public key, and these two keys are used to decrypt the locally stored symmetric key. Simple, right? Whoever said these people don't work for their money?

KEY ISSUES

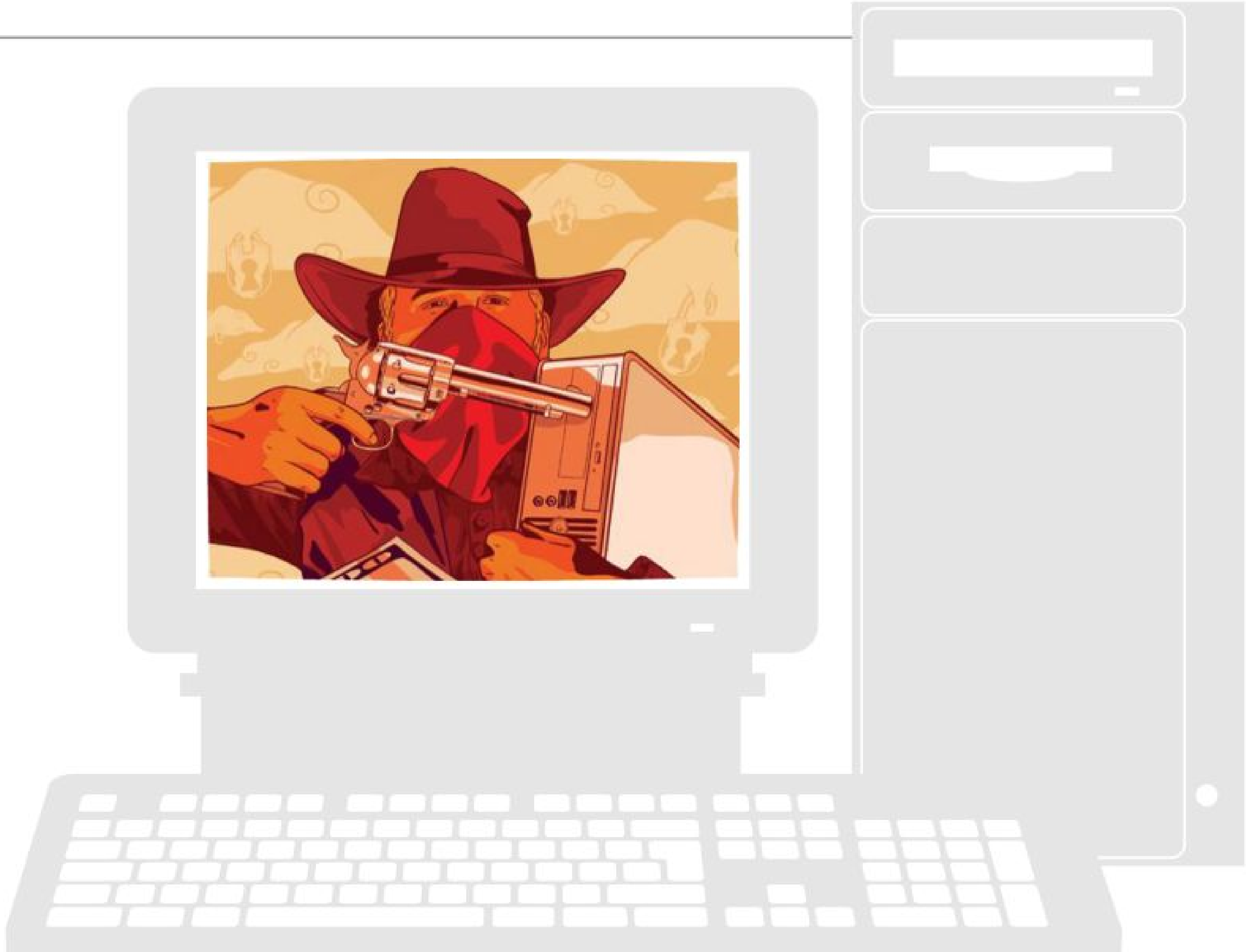
Actually, they don't. Ransomware and command and control servers can be readily bought or rented via the gloomier recesses of the dark web, and all this key management business can be taken care of with just a few clicks in a friendly interface. Having a single private key governing all victims is also not a terribly smart idea. It's straightforward enough to protect it as it's sent down the wire from the C2 server to the victim's machine over HTTPS or SSH, but a suitably meticulous researcher would, given enough time and a retainer, be able to extract it from memory during the decryption phase. In this way, paying the ransom once (or maybe a few times) could provide decryption capability for everyone. Which is not really what malware authors want, and why more advanced key distribution is generally used.

There's been a number of high-profile cases where a ransom has been paid and data has been liberated. For example, in 2016, a hospital in Los Angeles coughed up 40 bitcoins ($17,000 at the time) after being infected with the Locky ransomware. In life or death situations like this, it's easy to see why paying the ransom is a reasonable option. The sum of money involved may well be less than the daily cost of working around a crippled network.

Even if the crooks don't provide a decryption key, the ransom payment may be dwarfed by these costs, so from an accounting point of view, the victims aren't that much worse off. Hospitals, and indeed all reputable organizations, ought to have a watertight backup regimen in place, but restoring a whole network under considerable pressure is a complicated business. Consider how long it would take you to restore your machine's software, configuration, and data after it was wiped, then multiply this number by at least several hundred. Locky evolved over 2016 to become one of the (then) most-detected pieces of malware in the wild, eventually being localized in 30 different languages, and no longer requiring C2 infrastructure—which, if it's located in a friendly jurisdiction, is easy enough for authorities to shut down once an outbreak becomes prevalent enough.

Some malware is selective about what it encrypts; it may just encrypt documents (based on file extensions) and leave the rest of the operating system intact. Doing this means that it only requires user permissions to run. If you're lucky, this means that it's easy to clean up, at least once the source of the infection is tracked down, and so long as backups were taken beforehand. Of course, people have come up with ingenious ways of hiding scripts, and getting these infections to subsequently resurrect themselves. There's nothing more frustrating than thinking you've recovered everything to the pre-outbreak state, only to have it all come undone.

"Fileless malware" is becoming the new norm, however. This often travels by poisoned documents (PDFs in particular), which contain some script or code to fetch hostile code from the Internet, and inject it directly into memory. This makes it terribly tricky to detect.



MAKES YOU WANNACRY

The WannaCry damage could have been much worse had it not been for the actions of one Marcus Hutchins (aka MalwareTech), a security researcher who noticed WannaCry was trying to contact a server at an unregistered domain. Feeling inquisitive, he duly registered the domain and set up a sinkhole, a server designed to capture information, which had the effect of neutering the malware. Once infected machines were able to contact this domain, they stopped trying to infect other machines—in short, Hutchins had found a killswitch.

Further variants of WannaCry appeared in the aftermath, and mercifully killswitch domains were found for these, too. Hutchins became something of a hero overnight, which makes the next part of the story quite upsetting. In August 2017, he was in Las Vegas attending the Def Con hacker conference, and was promptly picked up by the FBI on hacking charges relating to the Kronos banking trojan, to which he admitted contributing code as a teenager. In July 2019, Hutchins was effectively granted his freedom, with the judge sentencing him to time already served, and even recommending he seek a pardon. This could have gone much worse for Hutchins; the plea deal he accepted could have seen him spend a decade in jail.

We've long commented that technology is moving faster than laws can keep up with. People doing security research have to walk a fine line. They are bound by a treaty known as the Wassenaar Arrangement, by which signatory nations agree to implement regulations governing software that could be used maliciously. The agreement was reworded in December 2017 to make special provisions for security researchers, who may have previously risked prosecution by sharing tools or vulnerabilities across borders.

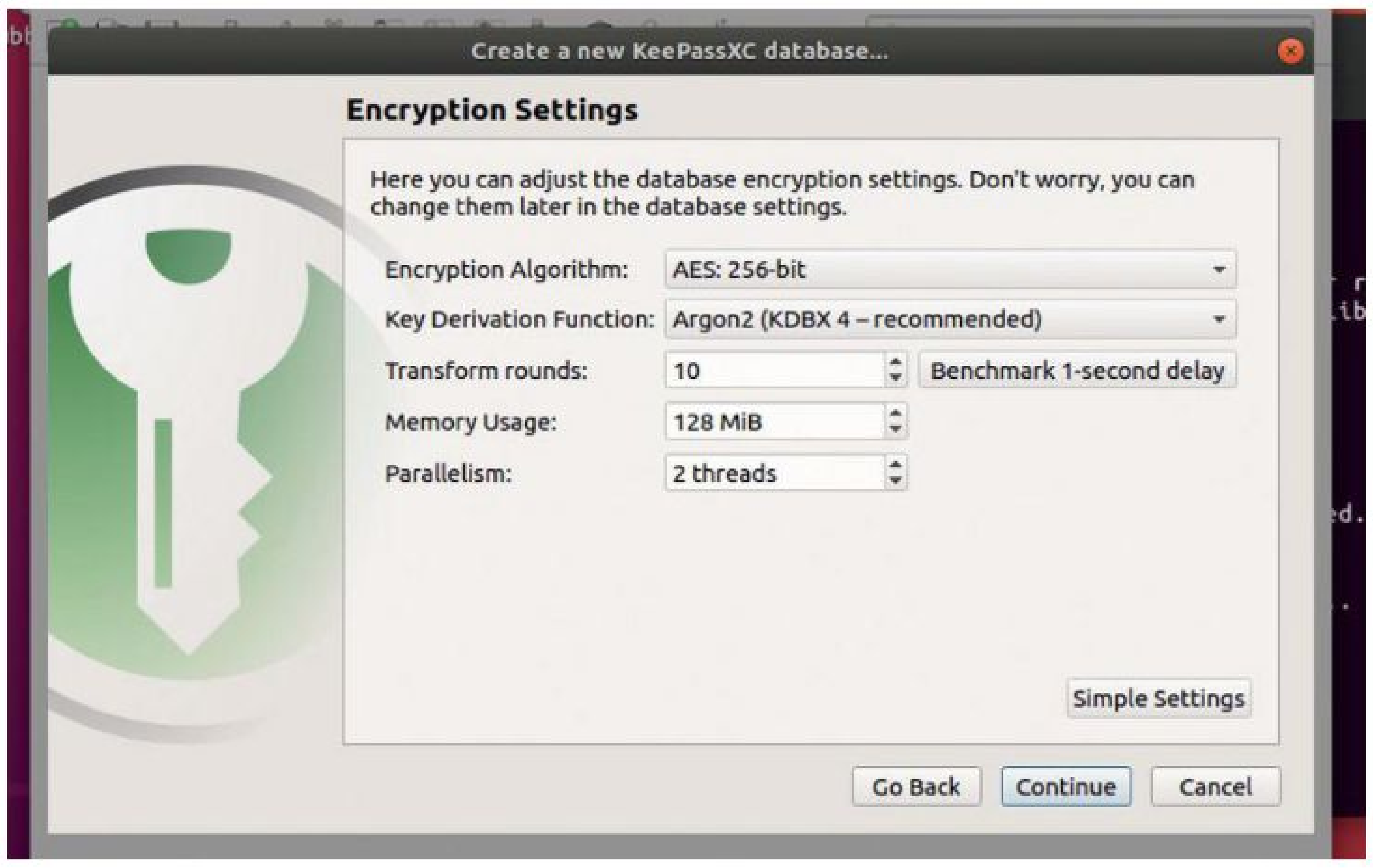
SOCIAL ENGINEERING

CONVINCING PEOPLE TO DO THINGS NOT IN THEIR INTERESTS HAS BECOME QUITE THE ART FORM, SO DON'T BE FOOLED. CLICK HERE FOR PUPPIES...

There are all kinds of devious methods that unscrupulous scammers use to get hold of unsuspecting marks' data—whether it's tricking them to install ransomware or some other kind of malware, such as a keylogger, or having them visit a booby-trapped website and enter valuable credentials. Most people nowadays know better than to reply to an email purporting to come from a Nigerian prince who needs some help organizing a wire transfer for his considerable inheritance. Indeed, most scammers no longer bother with these kinds of ruses; their game has been considerably upped.

They may play on local events, especially natural disasters. They may also send targeted email based on public information harvested from the target's social media accounts. For this reason, you should be extremely careful about what information you broadcast publicly about yourself. Knowing your interests, location, or even those of your friends is enough to gain a data-mining foothold. WannaCry and others like it exploited an unpatched vulnerability in Windows to spread, but this is comparatively rare. Most ransomware, and indeed most unauthorized access to computers, is installed by unwitting users being schemed and duped.

Fraudsters send email from domains that at a glance look legitimate—say, max1mumpc.com—or direct you to counterfeit websites at such domains. It's incredibly easy to cosmetically clone an entire website with open-source spidering tools that have legitimate uses. Widgets and search facilities are harder to reproduce, but if you can dupe victims into thinking the site is real long enough for them to enter their username and password, you've already won. People tend to drop their guard considerably if they feel they are communicating with a friend, so contact lists from plundered email clients are valuable, too. Social media accounts then become like gold for scammers.


Create a new KeePassXC database...

Encryption Settings

Here you can adjust the database encryption settings. Don't worry, you can change them later in the database settings.

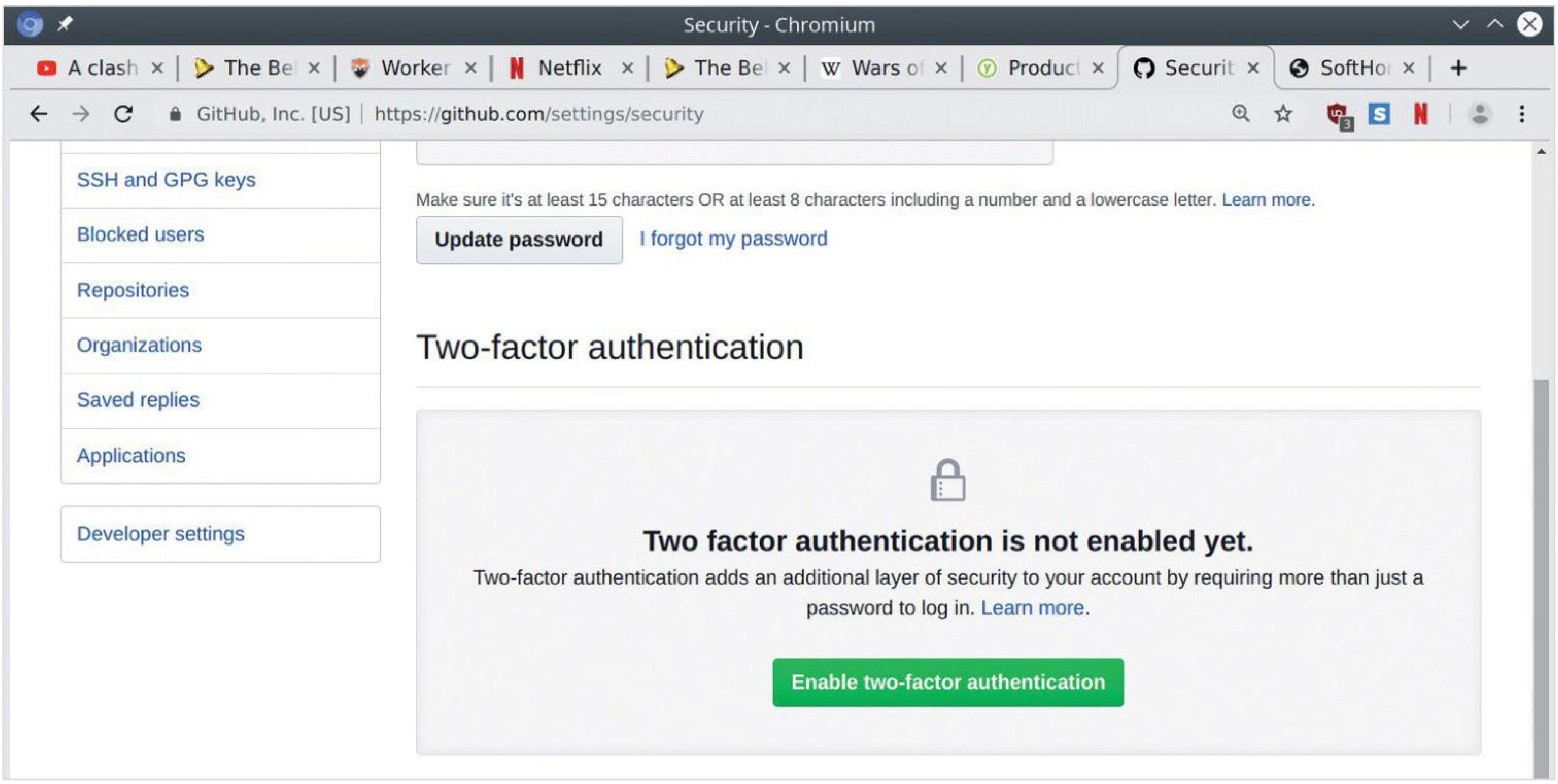
Encryption Algorithm: AES: 256-bit
Key Derivation Function: Argon2 (KDBX 4 – recommended)
Transform rounds: 10
Memory Usage: 128 MiB
Parallelism: 2 threads

Benchmark 1-second delay
Simple Settings
Go Back
Continue
Cancel

KeePassXC's advanced encryption settings are nothing if not impressive—however, the defaults are fine.

If you use Facebook, it offers a few ways you can secure your account. In particular, you can nominate a person or persons whom you trust so that, in the event you get hacked, they can trigger a password reset for you. You'll find these and other options in the "Security and Login" section of Facebook's settings.

You may have already witnessed hijacked accounts sending messages of the form "Help, I'm trapped in Timbuktu. Please send money," which are easy enough to sniff out. But with a little imagination and a little knowledge about the victim—and if you have access to their social media, you'll have plenty at


Security - Chromium
A clash
The Be
Worker
Netflix
The Be
Wars o
Product
Securit
SoftHo
GitHub, Inc. [US]
https://github.com/settings/security
SSH and GPG keys
Blocked users
Repositories
Organizations
Saved replies
Applications
Developer settings
Update password
I forgot my password
Enable two-factor authentication

Make sure it's at least 15 characters OR at least 8 characters including a number and a lowercase letter. Learn more.

Two-factor authentication

Two factor authentication is not enabled yet.

Two-factor authentication adds an additional layer of security to your account by requiring more than just a password to log in. Learn more.

GitHub supports 2FA. First set it up to use Google Authenticator, then you can use a U2F token.

© LINUX

your disposal—a much more convincing con can be crafted. Concerned parents, particularly those who aren't too tech-savvy, will readily part with cash if they think their children are in some sort of danger.

Human beings aren't really designed to remember passwords or indeed come up with secure ones, so it should come as no surprise that password-reset mechanisms or forgeries thereof are popular means for hijacking accounts. If you search your email address on Troy Hunt's https://haveibeenpwned.com website, you may well find it has appeared on one of the many lists of breached credentials that are now forever in the public domain.

This doesn't mean that email address is compromised, just that an account associated with it has been published—possibly something insignificant, and maybe even something that has since been secured. For obvious reasons, the actual credentials aren't listed, so you can't check their validity. But doing a thorough password audit is never a bad idea. If a password you used on a forum 12 years ago that's similar to any you use today is in any way traced to a different account, that account is at risk.

It's a painful process, going through all the places where you may have signed up, resetting passwords or canceling accounts, but it might just save your identity, or prevent your contacts getting phished, or something else beneficent. Rather than trying to remember a bunch of secure and different passwords, it's much more sensible to use a password manager. That way, you just need to remember a single strong password, and have the password manager generate (and remember) hard-to-crack, gibberish passwords for all the sites you use. There are plenty of cross-platform solutions that work through browser extensions and mobile apps, such as KeePassXC (https://keepassxc.org).

Fire it up, then click "Create new database." The default encryption and storage options are fine for normal humans, but feel free to turn everything up to 11 if you want. The next screen is the most important: It's where you must decide your master passphrase. Choose wisely, and consider writing it down and keeping it somewhere safe, but not somewhere it's likely to get stolen. Choose a location for your password database, and consider backing up this file (and all your important files) regularly. Now add your many, many freshly secured passwords. You can sort them into groups, and install the KeePassXC browser extension for Firefox.

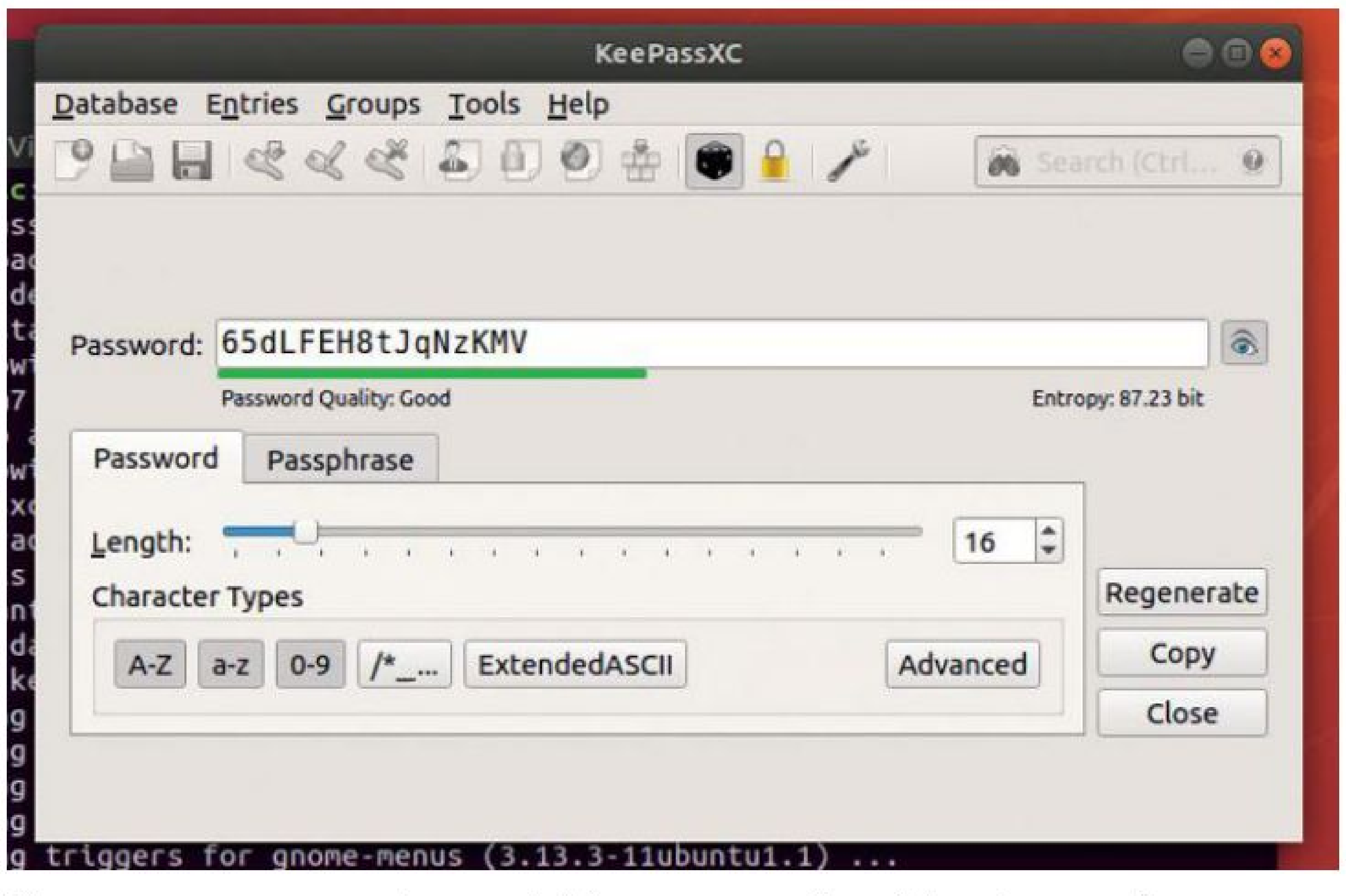
A MATTER OF FACTOR

Many services now offer two-factor authentication (2FA), where besides a password, some other token is required. Often this second factor is an SMS message, but there are problems with this. For one, a determined attacker may have the means to carry out a SIM-swap attack, whereby network staff are socially engineered (or bribed or blackmailed) into porting the victim's phone number to an attacker's SIM.

Mobile malware is becoming more and more prevalent (don't sideload apps you don't trust!), and if the victim's phone has fallen victim to such, their SMS messages are all up for grabs. The SS7 protocol that connects cellular networks has long been a source of concern for the security conscious. Once you have access to any cellular network—whether that's internally through a rogue employee or externally by some devious hackery—it's actually possible to access any other network and intercept or reroute messages as befits your whim. So, using SMS as a second factor is certainly stronger than using no second factor at all, but other factors should be used for critical services.

Hardware tokens and security keys are becoming much more widely supported as a second factor for popular services. The challenge-response card readers required by some forms of Internet banking are an example; they add credence to the notion that it is the account holder trying to make a given transaction, by proving that whoever is doing so has their card and PIN number. Unfortunately, these devices tend to spend a lot of time getting lost or running out of battery at the most inopportune moments.

That's the problem with real-world security: It has to take into account all the silly mistakes real-world humans are so good at. Let's be careful out there! ⏻



Password: 65dLFEH8tJqNzKMV

Password Quality: Good

Entropy: 87.23 bit

Length: 16

```
g triggers for gnome-menus (3.13.3-11ubuntu1.1) ...
```

You can now generate unwieldy passwords without worrying about having to remember them.

WE SECOND THIS MOTION

Google's Authenticator app for Android is a software 2FA solution, albeit a proprietary one, that uses the Time-based One-Time Password protocol (TOTP) to generate six- to eight-digit one-time codes for use as a second factor. It's widely supported, not just on Google sites, so if you have an Android phone, this is a free way to boost your security and reduce the chance of unfortunate takeovers. The magic of this is that, once a token is generated and shared between the site and the app, the same code is generated independently, based on the current time. The algorithm can tolerate clock skews and network latency, so the app and the site don't need to both keep exactly the same time.

Authenticator codes can theoretically be spied on, though an attacker would have to be watching you in real time for this to work, so for ultimate security, we recommend using a hardware solution, such as one of Yubico's YubiKey range. These support a variety of authentication protocols, and can work in tandem with a TOTP app as a Universal Second Factor (U2F), or authenticate with supported services via NFC (Near Field Communication) on a cell phone. They can also work as an unlock key for a password manager service. Which is nice.

GAMESCOM 2019 ROUND-UP

A LOOK AT WHAT THE WORLD'S BIGGEST GAMING EVENT REVEALED

BY CHRISTIAN GUYTON

Gamescom 2019 kicked off in August, promising to be bigger and better than ever. With a record 373,000 visitors, it plays host to almost every major developer and publisher at the Koelnmesse event center in Cologne, Germany. This year's iteration featured a never-before-seen pre-event announcement show, named Opening Night Live, and hosted by charismatic Game Awards creator Geoff Keighley. Opening Night Live threw out a huge variety of new announcements, trailers, and interviews, more closely resembling an E3 stage show than anything Gamescom has offered before.

A combination of brand-new reveals, further trailers for upcoming games, and playable demos draws global attention to Cologne, and for obvious reasons, we'll be focusing on the games that will be coming to PC. That means we're not going to be delving into the wide range of indie games coming to Nintendo Switch, or the PS4 exclusives that do such a good job of making us (briefly) jealous of the consoles.

There's plenty to be excited about for the PC crowd, though. With all the big players participating—EA, Microsoft, Activision Blizzard, and more—there were plenty of new games on show. VR games and platforms had a strong showing, as did Nvidia's ray-tracing hardware, with more games than ever added to the selection of titles supporting RTX functionality. While Gamescom was previously a consumer event, built more around gaming culture and public access to game demos, it has almost caught up with E3 in terms of proper relevance to the industry, with more new game announcements this year than any before.

That's not to say that the culture has fallen by the wayside, though; walking the cavernous halls of the Koelnmesse, every turn of the head had us spotting more cheering crowds of fans, more people in impossibly detailed cosplays, more Internet memes come to life. There's a palpable energy here—let's find out what there was to see.

STRANDING OVATION

We're going to start with *Death Stranding.* The supposed PS4 exclusive recently had that status quietly revoked in its marketing material, driving suspicions that Hideo Kojima's bizarre magnum opus might make its way to PC. And, boy, we hope it does. New gameplay footage showed a host of new features, including everything from urination to baby care to a Geoff Keighley hologram. Yes, you read that right. Norman Reedus's futuristic courier Sam keeps his own bladder in his in-game inventory, rather than in his abdomen, like a normal human being. It fills up over time, and can be emptied whenever you please, though the game does remind you not to relieve yourself near other people.

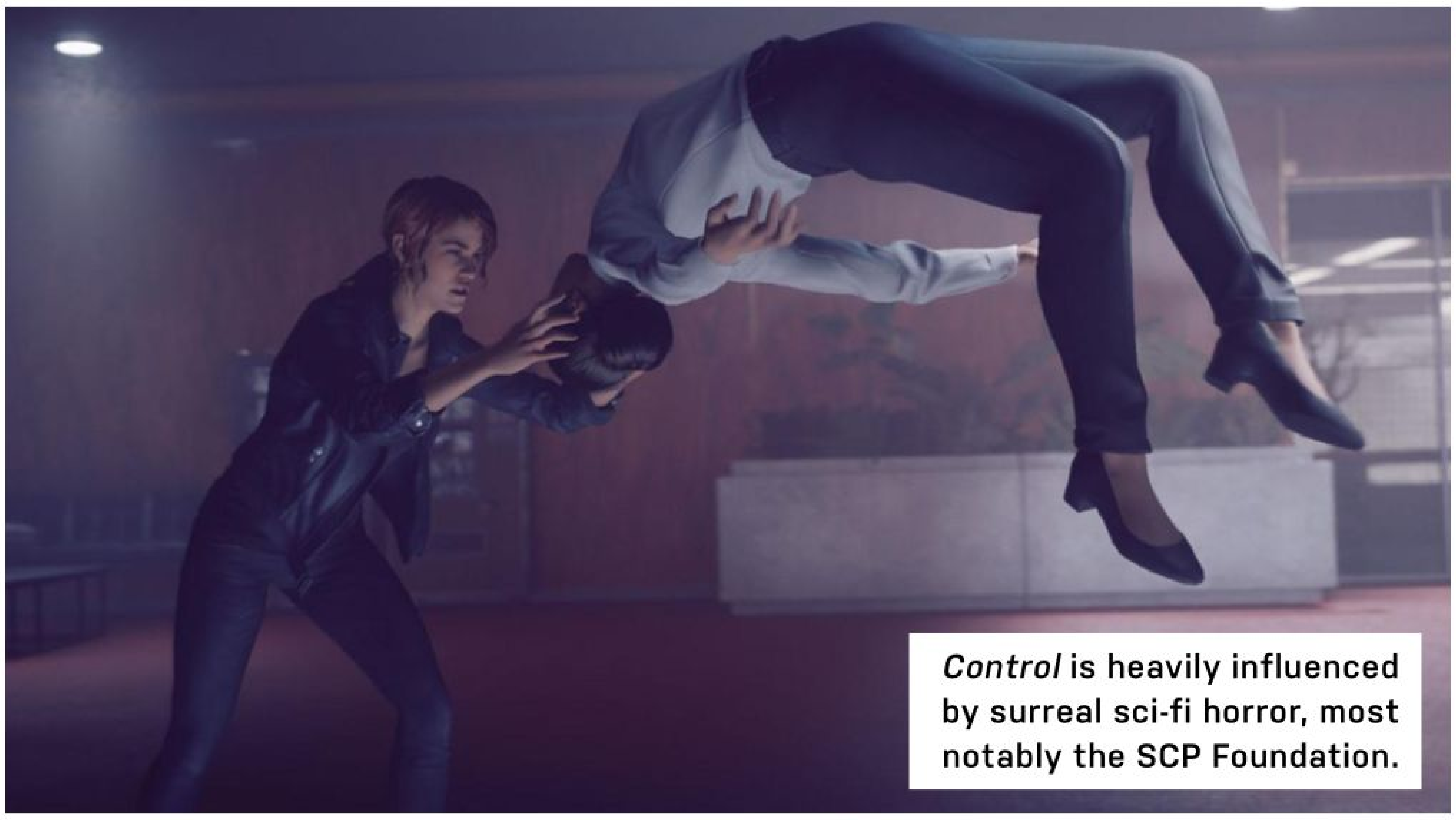
The more we see of *Death Stranding,* the more we hope it does end up coming to PC. Kojima is a true madcap auteur, eager to somehow meld epic philosophical storytelling with, uh, Mads Mikkelsen standing around being angular and smoking an absurd number of cigarettes. No, we've got no idea how the plot of *Death Stranding* is going to work, but Kojima's announcement at Opening Night Live did show us a bit more of what the world will feel like: a desolate but strangely beautiful mountainous environment that encourages tumbles down rocky hillsides and use of Sam's high-tech extending ladder, which can double as a bridge.

Another game getting some heavy gameplay focus at Gamescom was *Control,* the new baby of *Max Payne* developer Remedy Entertainment. The game casts you as Jesse Faden, newly inducted director of the Federal Bureau of Control, a sort of secret paranormal FBI. There's no paperwork and press conferences for Jesse, though, as she's thrust directly into a reality-bending skyscraper with naught but a magical gun called the Service Weapon, and a steadily growing roster of supernatural powers.

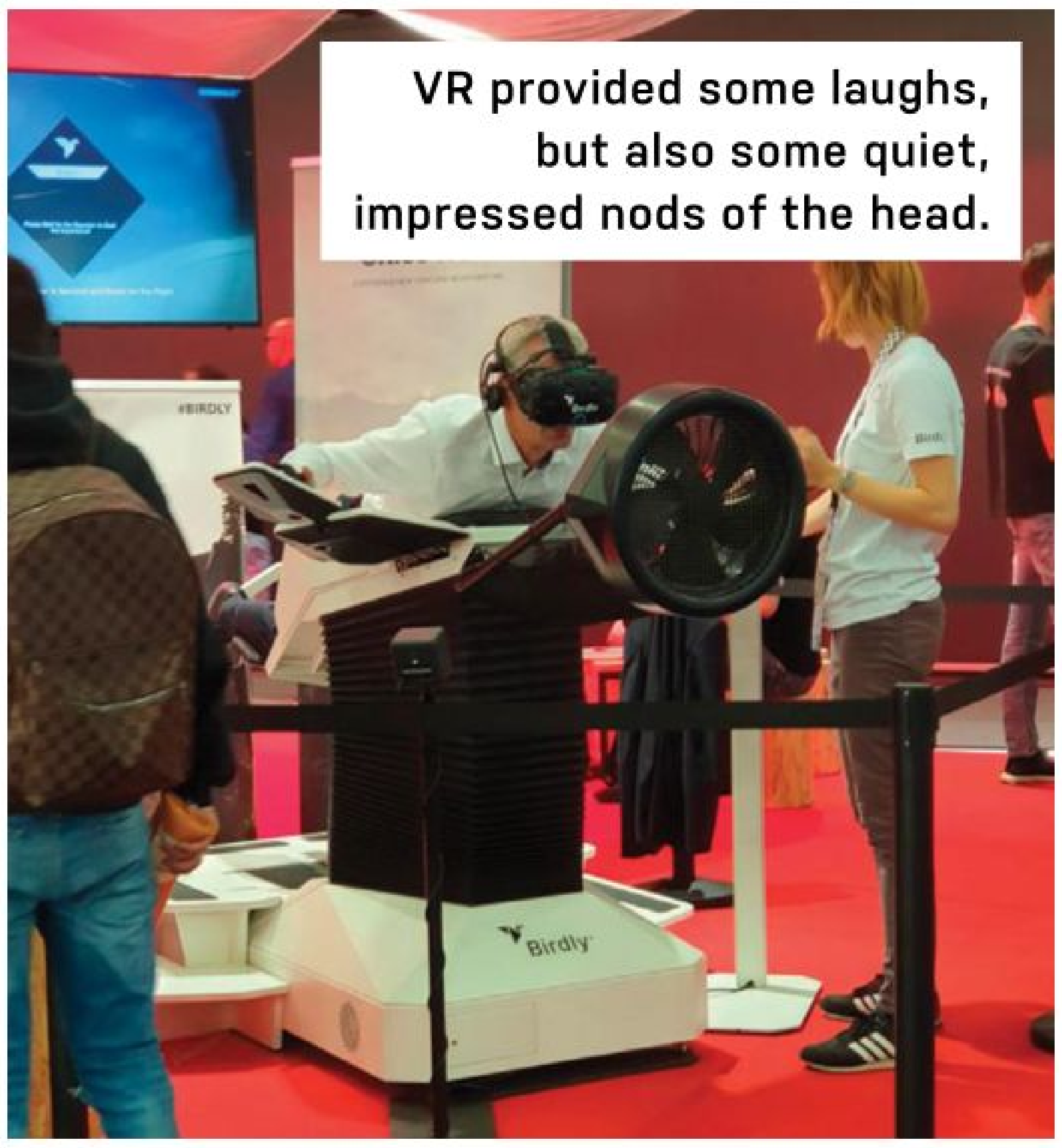
The Service Weapon can shift form, depending on the situation, and Jesse slowly gains more and more superhuman abilities: telekinesis, levitation, and possession. The game is extremely stylized and supports full ray tracing, showing off the awesome, twisting interior of the FBC headquarters. If you've played Remedy's cult hit *Alan Wake,* the gameplay should look familiar; battling paranormal entities and possessed humans, with a mix of both conventional and highly unconventional weapons.

Sticking with the third-person shooters for now, Gamescom also treated us to another look at *Gears 5,* which has apparently abandoned the *"of War"* part of the series's title. That could be appropriate, as the new cinematic trailer showed a world that appears to have been utterly devastated by the villainous

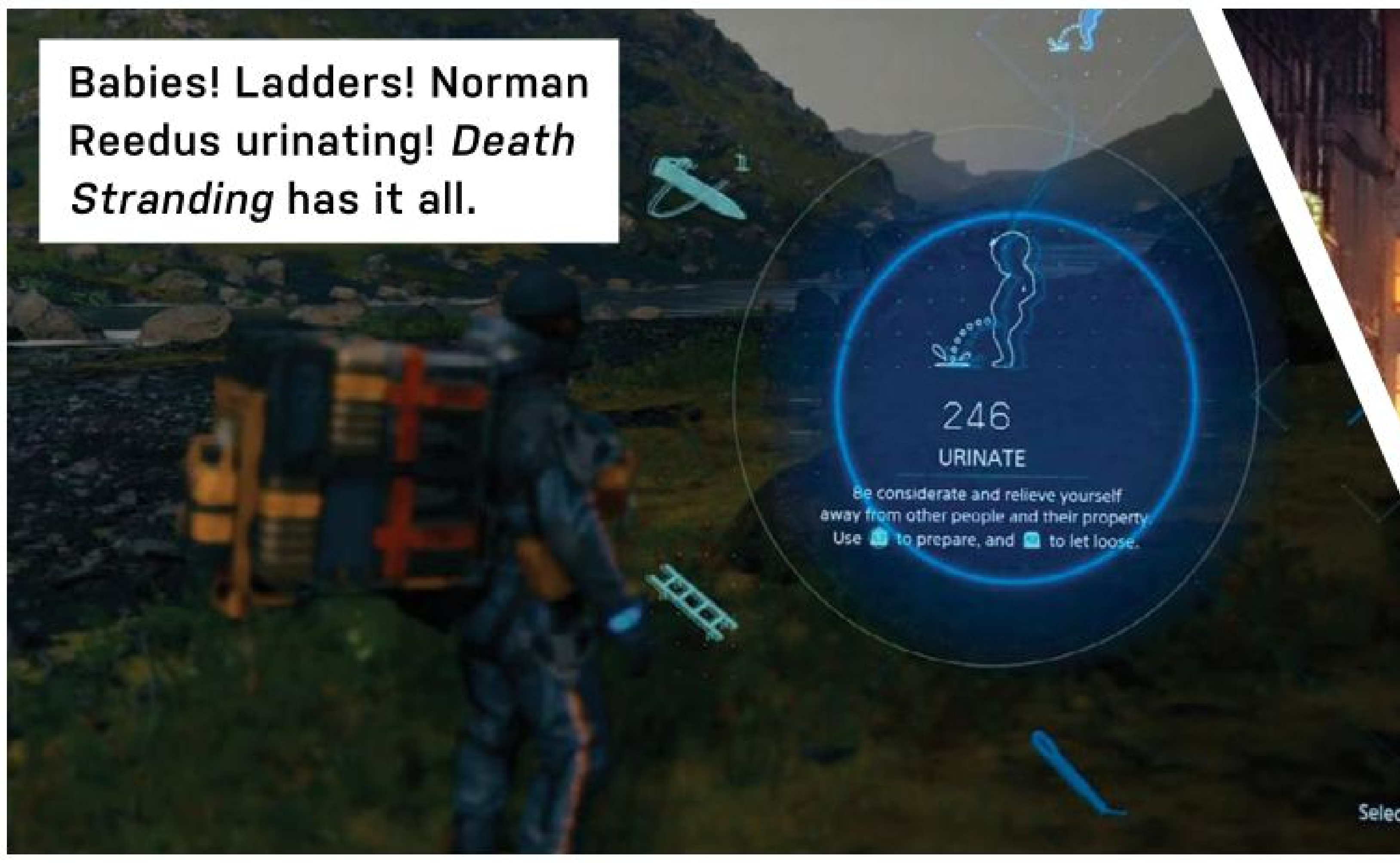
© WWW.AUDACITYTEAM.ORG



Control is heavily influenced by surreal sci-fi horror, most notably the SCP Foundation.

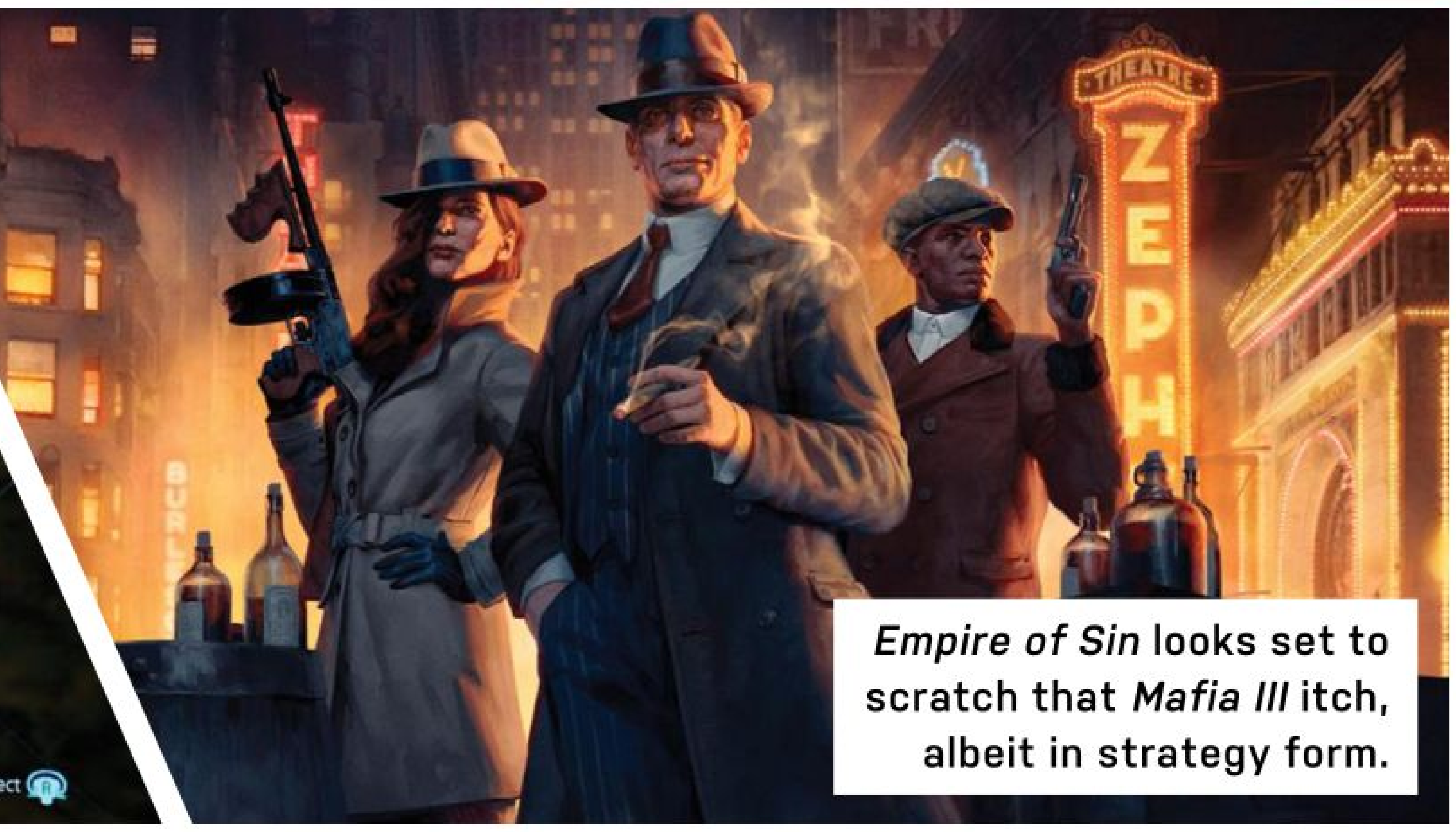


VR provided some laughs, but also some quiet, impressed nods of the head.



Babies! Ladders! Norman Reedus urinating! *Death Stranding* has it all.

246
URINATE
Be considerate and relieve yourself away from other people and their property.
Use to prepare, and to let loose.
Select

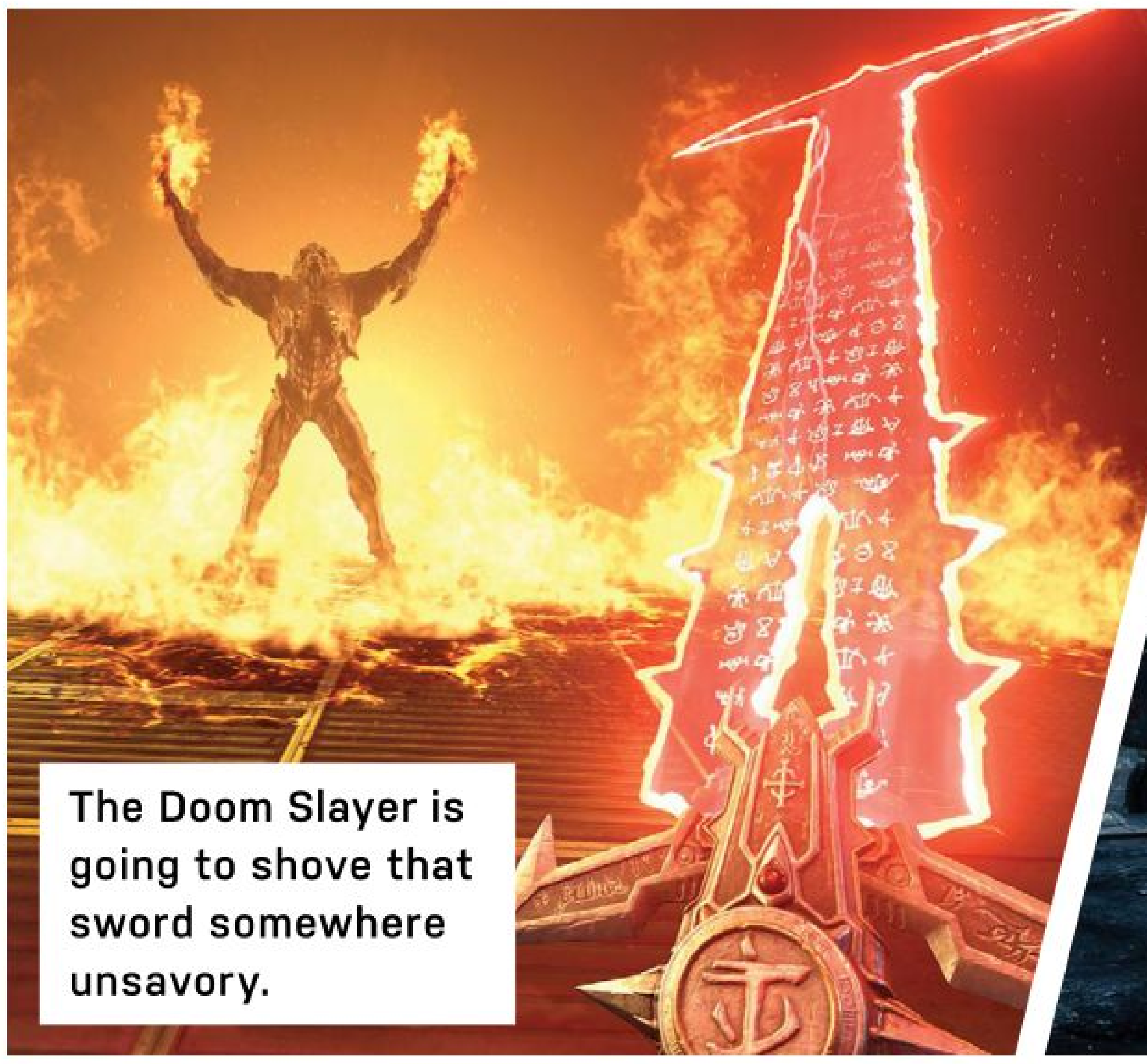


Empire of Sin looks set to scratch that *Mafia III* itch, albeit in strategy form.

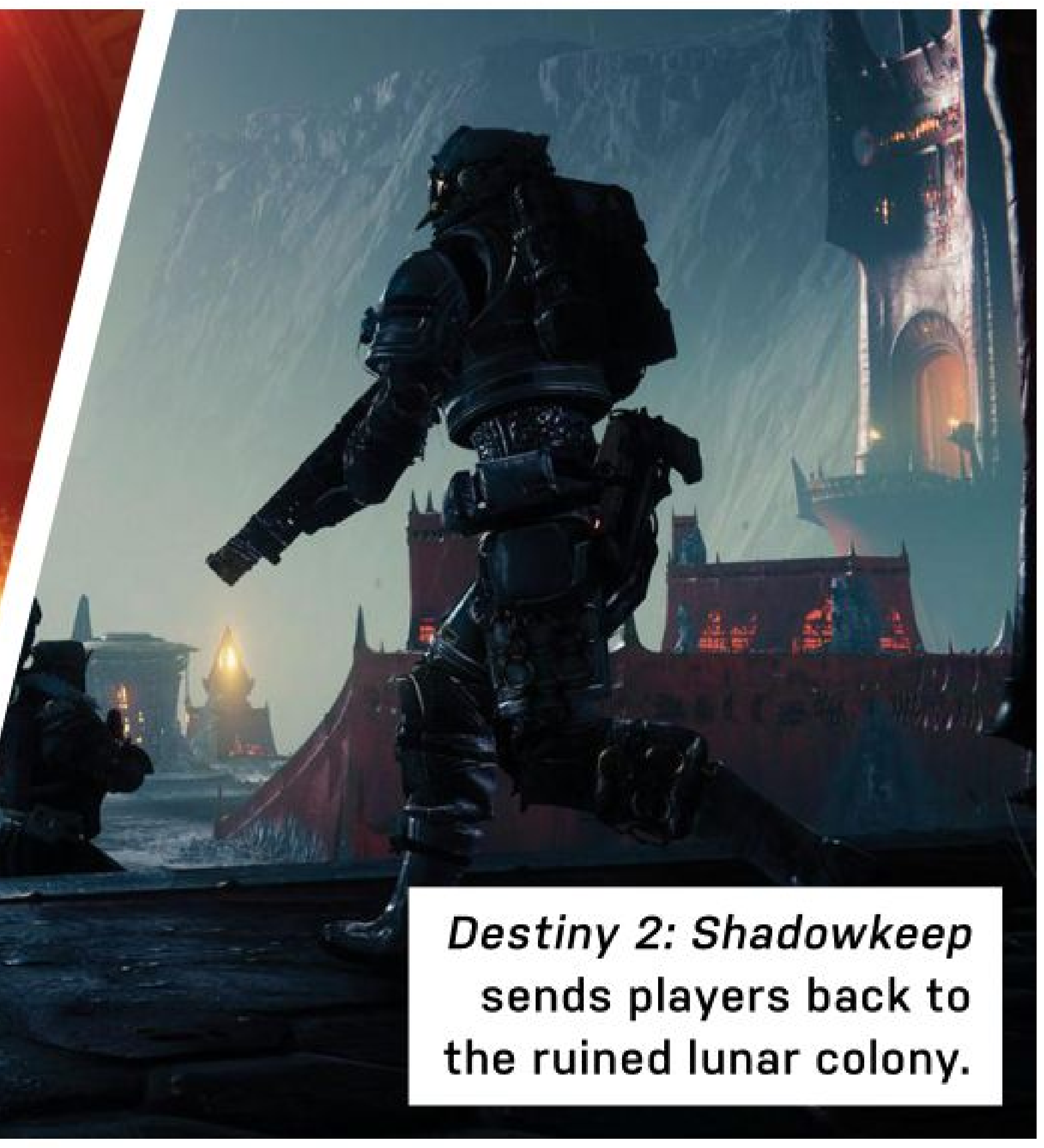
THEATRE
ZEPH

Visitor numbers increased for the fourth year in a row.

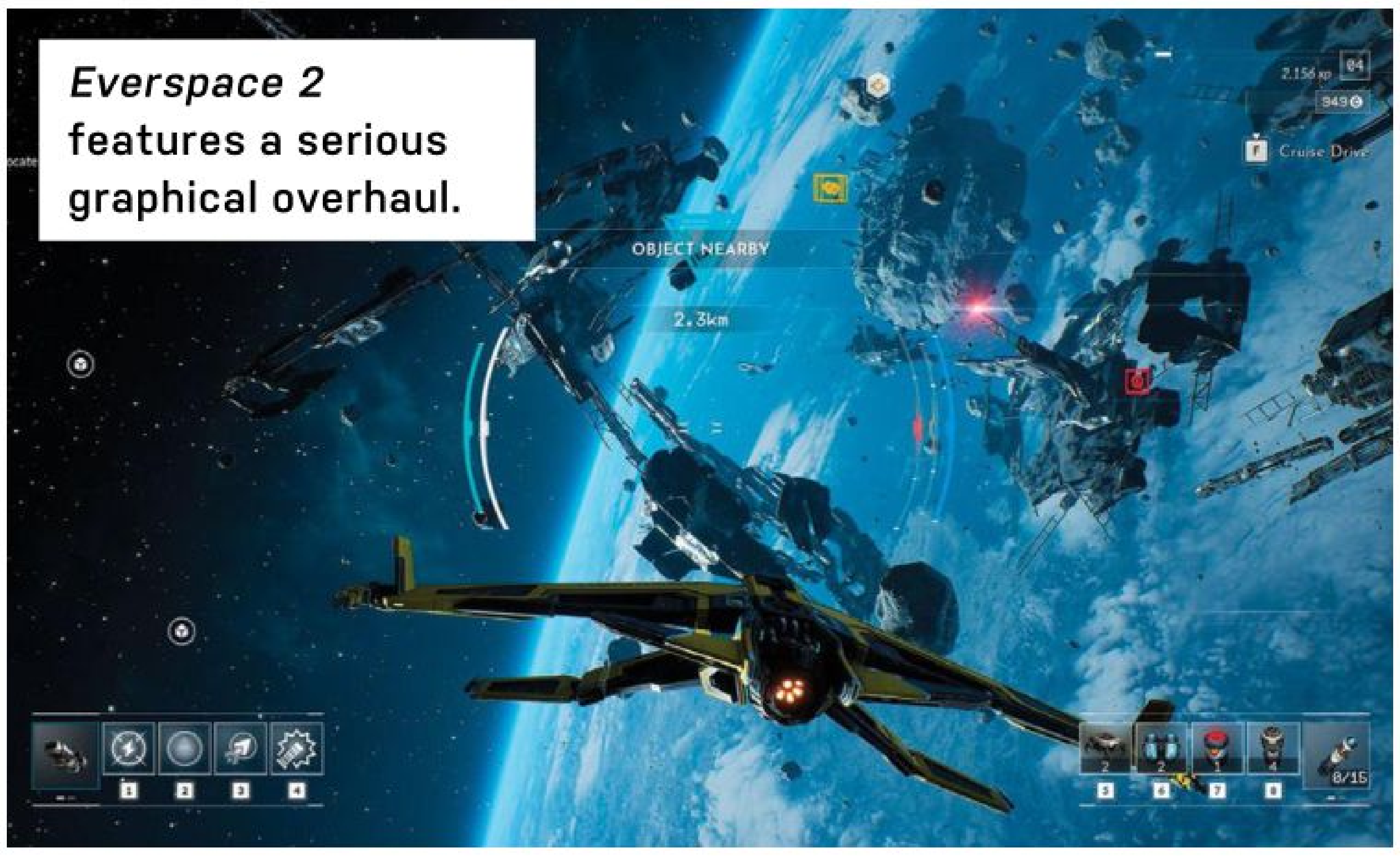
BESUCHT UNS IN
HALLE 5.2
DISCORD
COME SEE US IN
HALL 10.1
BOOTH #071



The Doom Slayer is going to shove that sword somewhere unsavory.

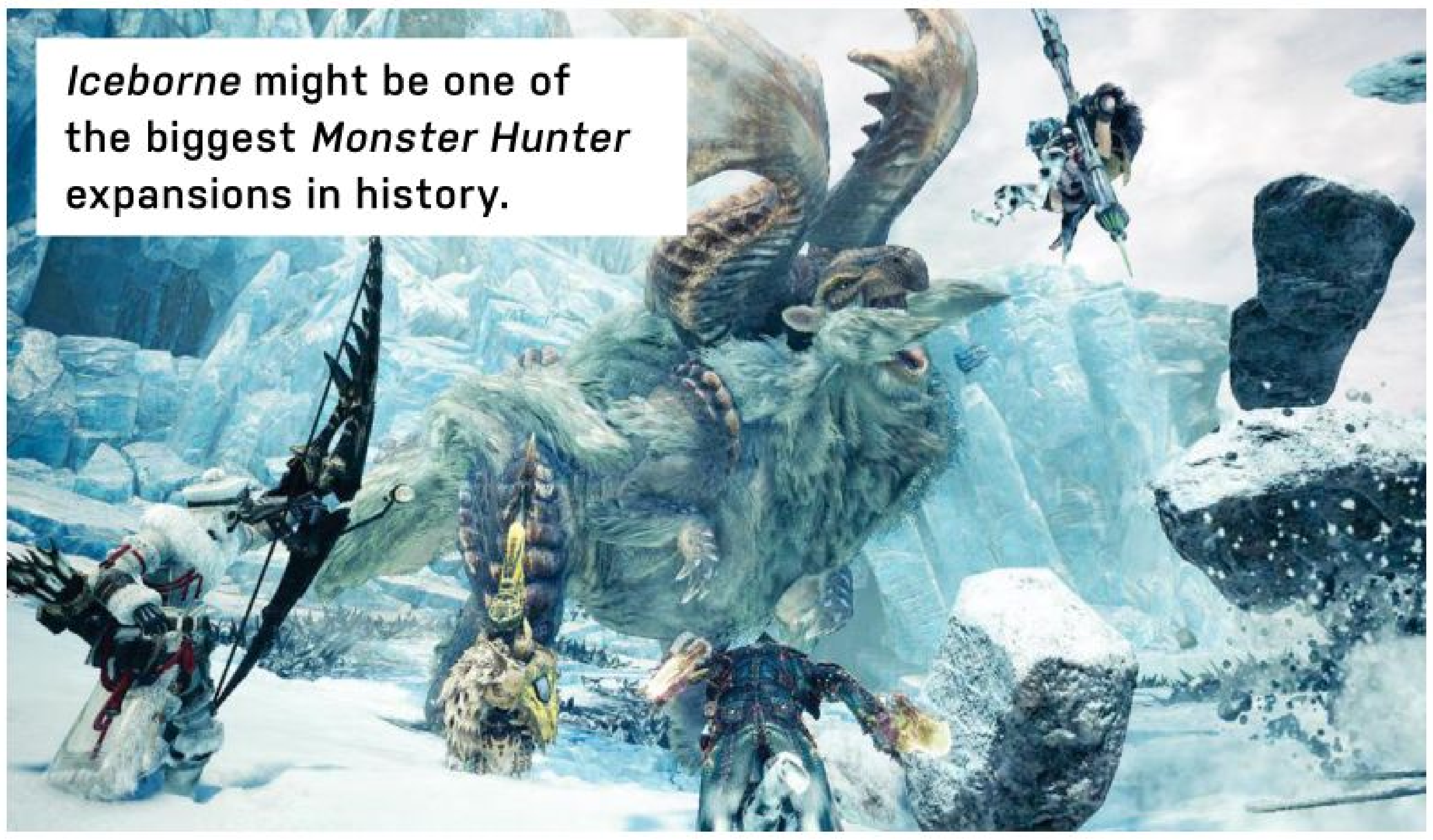


Destiny 2: Shadowkeep sends players back to the ruined lunar colony.



Everspace 2 features a serious graphical overhaul.

OBJECT NEARBY
2.3km
Cruise Drive



Iceborne might be one of the biggest *Monster Hunter* expansions in history.

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Locust Horde. The titular Gears soldiers themselves, on the other hand, are still alive and kicking, the new trailer showing a squad of them deliberately getting captured in order to infiltrate a Locust base and proceed to shoot, stab, and chainsaw their way out. *Gears 5* was also pushed heavily by AMD, because it comes optimized for DirectX 12 and AMD GPUs, and will be patched post-launch to support AMD's upcoming FidelityFX image sharpening.

EXPANSION FASCINATION

A few other upcoming games threw out new footage to announce new modes or unseen content, such as Ubisoft's next nail in Tom Clancy's coffin, *Ghost Recon: Breakpoint,* which showed off its competitive Ghost War mode. A four-versus-four mode that throws out a few interesting mechanics, such as shifting weather conditions and surveillance systems scattered around the shrinking map, it looks mostly like more of the same from Ubi, so if you were a fan of *Ghost Recon: Wildlands,* this could be for you.

Doom Eternal also showcased its new multiplayer mode, simply entitled Battlemode. After the weak PvP showing in *Doom 2016,* id Software is making new strides in competitive play by producing an asymmetrical experience that places a single player into the blood-drenched boots of the legendary Doom Slayer, while two other players face off against him as a variety of beloved demons. The Slayer is fully loaded with armor and all manner of deadly weapons, while the demon players can spawn in AI enemies and utilize an assortment of hellish abilities.

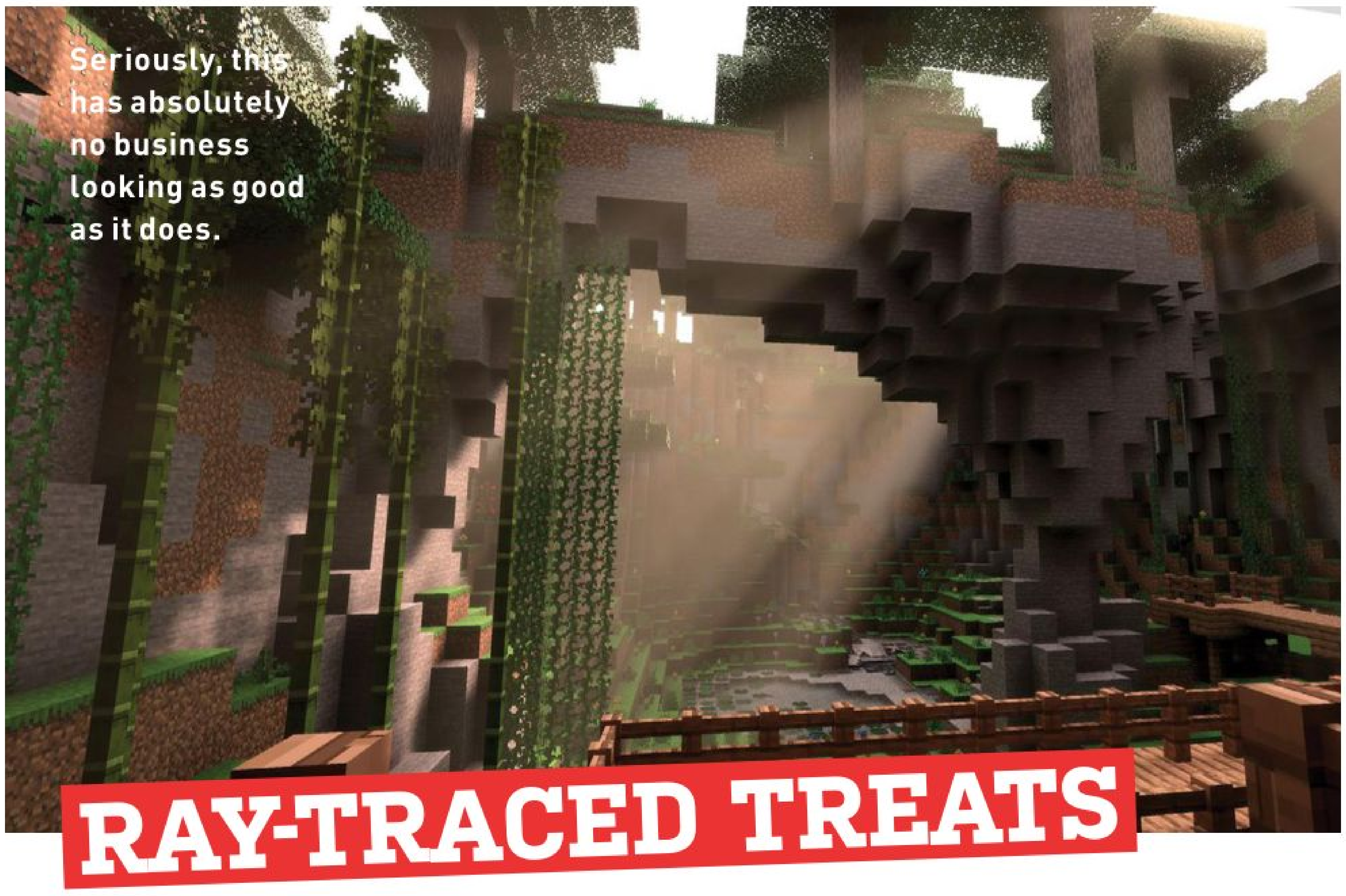
The biggest expansion of the event was the hotly anticipated *Iceborne* DLC for Capcom's epic *Monster Hunter: World. MH:U* won "Best Ongoing Game" at the coveted Gamescom Awards, with *Iceborne* making an extremely strong case for the game's survival, despite it being almost two years old and lacking any sort of competitive scene. The chilly new expansion comes with new monsters to slay and a gorgeous new environment to explore, along with the new Master Rank quests. The Master Rank promises greater difficulty and better rewards than ever before, something that the series's die-hard fans have been crying out for ever since the game's release.

The last big expansion on our list is the upcoming *Destiny 2* DLC, *Shadowkeep.* With Bungie free from the shackles of Activision's "partnership," it's looking to take the *Destiny* IP in bold new directions, with a free-to-play version of the vanilla *Destiny 2* experience (entitled *Destiny: New Light),* and a plot-heavy expansion that sees players returning to Earth's moon, hugely changed from its appearance in the first game. Bungie is promising big changes for the expansion, including an updated armor system, and a return of many series villains as shadowy replicas of their former selves. The *Destiny* lore is as deep as it is nebulous, and *Shadowkeep* assures that many questions will be answered.

There was also a number of new content announcements for a handful of small games, including the *Crash and Sunburn* expansion for super-fun stunt cycling game *Trials Rising,* the *Botanica* update for strategy title *Anno 1800,* and the *Colosseum of the Unseen* expansion for recent action-RPG release *Killsquad.*

BRAND NEW

Gamescom 2019 threw out plenty of exciting new announcements, too, many of them revealed during the Opening Night Live stream, which garnered more than half a million simultaneous viewers according to the event's organizers. One of the first games announced was *Everspace 2,* sequel to 2017 spacefaring roguelike *Everspace.* The reveal trailer (set to a thumping electronic soundtrack) showed off all the ways that the second



Seriously, this has absolutely no business looking as good as it does.

RAY-TRACED TREATS

A hot topic among PC gamers right now is the rising "success" of real-time ray tracing in games. If you can picture us making air quotes with our fingers as we type those words, you're right on the money; we're still dubious about the advantages of RTX lighting and reflections as long as they remain pretty much nixed by the inevitable damage to frame rates. The trade-off of graphical fidelity against performance makes ray tracing unpopular among many gamers, particularly fans of twitch shooters. Online FPS *Battlefield V* utilizes ray tracing for lighting effects, but on anything less than an RTX 2080 Ti, the hit to frame rates at higher resolutions is too much to bear.

Performance issues aren't the only thing plaguing the efforts of Nvidia to push ray tracing to a wider array of gamers, despite a retroactive move that patched RTX functionality on to some of the cheaper GTX cards, most notably the GTX 1660 Ti (though the performance was questionable at best). To date, there is only a handful of games that support RTX, and not all of them utilize the full range of ray tracing's potential, often only using it for global illumination, rather than the flashier reflection animation.

Thankfully, it seems Nvidia has been busy in preparation for Gamescom. It has put out new trailers for a large number of games that will be releasing with RTX support. This includes upcoming big-name titles such as *Cyberpunk 2077, Watch Dogs: Legion,* and the *Call of Duty: Modern Warfare* reboot, as well as a few current releases to add to the RTX livery, such as *Wolfenstein: Youngblood.* Most excitingly, the wound left by the cancelation of the eagerly anticipated Super Duper Graphics Pack for *Minecraft* was salved by the announcement of full RTX lighting and an overall graphical overhaul for the indie darling. Microsoft and Nvidia teamed up for the game's new look, which is—staggeringly—perhaps the best-looking example of real-time ray tracing we've seen. Go watch the trailer.

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Hack-and-slasher *Ghostrunner* has some gorgeously bleak cyberpunk environments.

Little Nightmares 2 sees the iconic yellow coat return.

© ONE MORE LEVEL, TARSIER STUDIOS

game will be bigger and better than the original, with new ships, tentacle-waving giant space monsters, and in-atmosphere air combat set above a dusty planetary colony. This sequel also looks to be a significant graphical upgrade from the first game, with some seriously gorgeous zero-G environments to explore and scavenge, as well as some impressive-looking explosions.

That's not the only game coming back for round two. Physics-heavy spaceship-builder *Kerbal Space Program* is finally getting a sequel, with developer Private Division showing off a CGI trailer that was equal parts slapstick hilarity and enticing interstellar exploration, thanks to the epic strains of French musical duo M83. For those not in the know, *Kerbal Space Program* (or *KSP* for short) tasks players with operating a spaceflight program, right down to building and designing every aspect of your spacecraft, in order to take your Kerbals—the little green men who pilot your spaceship—to the stars.

Thanks to a painstakingly realistic orbital physics engine, *KSP* proved both fun and educational, to the point where even NASA expressed an interest in the game's simulated space action. The sequel is taking the Kerbals to all-new locales, with epic colony-building on oceanic moons, and the usual selection of catastrophic rocket failures. If it's anything like the original, the sequel will likely feature new ways to obliterate your poor Kerbals in fiery explosions, probably because you mistimed the release of a single locking clamp on the second rocket stage (or something equally trivial—no, you're not the only one who gets irrationally frustrated by that game).

Another new futuristic game coming from Private Division (though developed by V1 Interactive, a team composed of veteran *Halo* developers) is *Disintegration,* claiming to have an in-depth single-player campaign, a welcome sight in this world of PvP-only titles, as well as a motley cast of humorous robotic heroes, and a strategy element. While ostensibly a first-person shooter played from the driver's seat of a heavily-armed "gravcycle," *Disintegration* also hands the player a squad of ground forces to command in real time. It's an interesting premise that looks like it'll be either extremely fun or very stressful.

Sticking with science fiction, but swapping to a wildly different setting, we also saw new title *Ghostrunner* from One More Level, developer of ultra-violent top-down shooter *God's Trigger. Ghostrunner* shifts the perspective to first-person, but keeps the pace rapid and the combat gory. Casting you as a cyborg swordsman in a cyberpunk dystopia, the action is reminiscent of *Titanfall 2's* high-speed wallrunning and grappling. Enemies fall into gory chunks with a single slash from your sci-fi blade, and just one shot from their guns can bring about a red-tinted "You're Dead" screen. Momentum is the focus here, though, so checkpoints are generous and respawn times are almost instantaneous. Our recommendation on release is that you check out some speedrunners on

STAND-OUT STADIA

Google Stadia was the hottest piece of hardware on show at Gamescom, with more triple-A titles being added to its burgeoning launch roster. Alongside *Assassin's Creed: Odyssey, Metro Exodus,* and *Destiny 2,* Google has added a number of new titles that will be available on Stadia from day one, including *Watch Dogs: Legion, Cyberpunk 2077,* and *Marvel's Avengers.*

As far as we're concerned, the jury's still out. Demos performed better than the dicey showing at this year's E3, where the *Doom Eternal* demo proved to be visibly choppy when streamed on Google's new platform. Somewhat tellingly, though, most of the games on show were single-player titles, free of the rigors that online twitch shooters might experience while being streamed.

Google has doubled down on marketing for the Stadia, pushing ads across social media, and commandeering a large section of the floor at Gamescom to promote its new product. The tech remains largely under wraps, but Google is clearly confident that the platform will be successful—though rumors of a cadre of Stadia-exclusive titles have yet to be cast into reality.

Pricing is still an issue of concern to many consumers, even those enticed by the minimalist nature of the Stadia. With no upgradable hardware and a guarantee of consistently powerful performance in Google's data centers, the need to keep your system up to spec is a thing of the past. Subscription fees are a concern to many gamers, though, as is the need to potentially pay for new titles on top of that. We'll have to wait and see.

All you need to buy is the controller. Well, and the subscription. And the games....

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YouTube, as opposed to our own woeful attempts at deathless runs.

WRAPPING UP

Other new games included *Humankind,* a historical strategy that offers the chance to rewrite human history; *The Settlers,* a remake of Ubisoft's worldbuilding series; and *Need for Speed Heat,* the latest in the street racer franchise. Another new IP revealed was *Empire of Sin,* an *XCOM*-esque title focusing on mobsters in 1920s Chicago. It's heavily stylized and comes with all the expected Prohibition-era speakeasies and overblown voice acting.

Gamescom also brought us a release date for the long-awaited *Mount and Blade* sequel, subtitled *Bannerlord.* A funky blend of strategy and real-time medieval combat, *Bannerlord* features massive sieges and an open-ended campaign that lets you build your legend however you choose, be that as a stalwart military leader or a thuggish underworld criminal. While the game has been in development for a long while, it was playable in beta form at Gamescom, and the release date was revealed as March 2020. Feedback from those who played it was mixed, though the large scale of *Bannerlord's* epic battles is undeniably impressive.

Little Nightmares, the charmingly dark puzzle platformer from Tarsier Studios, is also getting a sequel. Our yellow-jacketed hero returns, now with a companion who wears a brown paper bag over their head. All the usual staples from the first game return: creepy music, murderous hulking schoolteachers, and the use of ordinary household objects for ominous purposes. The reveal trailer showed us hospital beds hanging from ropes, flickering TV screens, and the menacing jingling of an old music box. Yes, we're back in horror territory, and we couldn't be happier.

Cybershoes®

Regardless of whether you're fully sold on VR or not, it's hard to deny that the Cybershoes are pretty darn cool.

© CYBERSHOES

Other publishers were eager to show off new gameplay. *Dying Light 2* brought more blood-splattered zombie violence, while *Wasteland 3* showed us a series of snowy fights through a post-apocalyptic Colorado. *Wasteland 2* was released all the way back in 2014, and this sequel was thought to be lost in development hell for some time. Thankfully, it's back, showcasing some great strategic gameplay against both human and mechanical foes. Another sequel shown at Gamescom was *The Surge 2,* albeit a sequel that nobody asked for. It looks surprisingly good, though, ditching the bland protagonist of the first game in favor of a fully customizable character, and stepping up the variety of weaponry. The original game was best described as sci-fi *Dark Souls,* while the sequel looks a bit more like sci-fi *Bloodborne,* with faster-paced combat, and some very unique weapons.

The last thing we want to talk about isn't a game at all, but an intriguing new peripheral: the Cybershoes. That's right, the virtual reality experience has now been further enhanced with the addition of VR shoes, a pair of high-tech slippers that come fitted with motion sensors and sole-mounted rollers. With these, the promise of simulated walking in VR grows ever more tangible to consumers, previously demanding a complicated and expensive 360-degree treadmill setup. Already compatible with a wide variety of VR titles, including *Skyrim* and *Doom VFR,* the Cybershoes could be the next step (pun intended) toward full-body virtual reality immersion. And, hey, come on: Cyber! Shoes!

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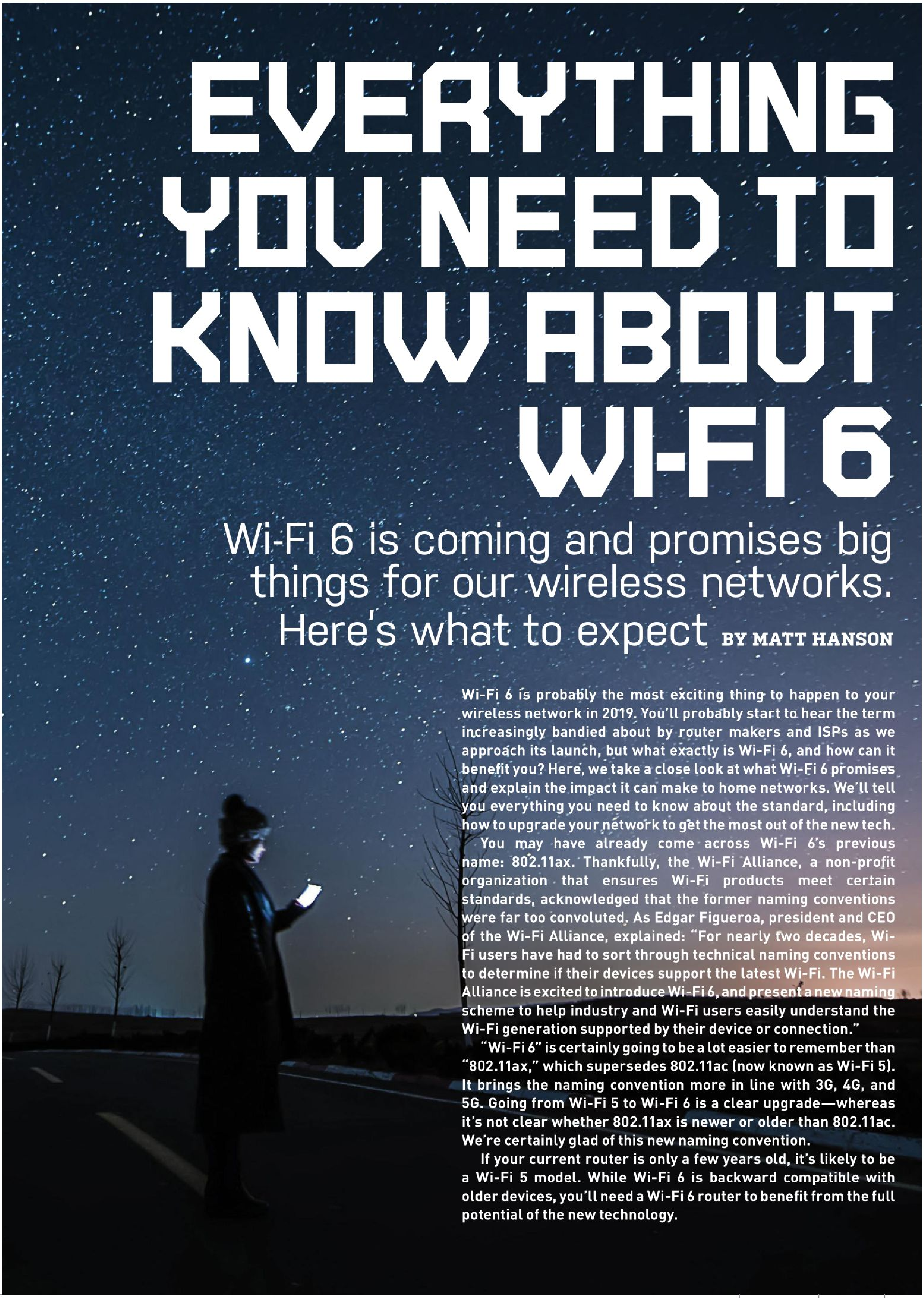


EVERYTHING YOU NEED TO KNOW ABOUT WI-FI 6

Wi-Fi 6 is coming and promises big things for our wireless networks. Here's what to expect **BY MATT HANSON**

Wi-Fi 6 is probably the most exciting thing to happen to your wireless network in 2019. You'll probably start to hear the term increasingly bandied about by router makers and ISPs as we approach its launch, but what exactly is Wi-Fi 6, and how can it benefit you? Here, we take a close look at what Wi-Fi 6 promises and explain the impact it can make to home networks. We'll tell you everything you need to know about the standard, including how to upgrade your network to get the most out of the new tech.

You may have already come across Wi-Fi 6's previous name: 802.11ax. Thankfully, the Wi-Fi Alliance, a non-profit organization that ensures Wi-Fi products meet certain standards, acknowledged that the former naming conventions were far too convoluted. As Edgar Figueroa, president and CEO of the Wi-Fi Alliance, explained: "For nearly two decades, Wi-Fi users have had to sort through technical naming conventions to determine if their devices support the latest Wi-Fi. The Wi-Fi Alliance is excited to introduce Wi-Fi 6, and present a new naming scheme to help industry and Wi-Fi users easily understand the Wi-Fi generation supported by their device or connection."

"Wi-Fi 6" is certainly going to be a lot easier to remember than "802.11ax," which supersedes 802.11ac (now known as Wi-Fi 5). It brings the naming convention more in line with 3G, 4G, and 5G. Going from Wi-Fi 5 to Wi-Fi 6 is a clear upgrade—whereas it's not clear whether 802.11ax is newer or older than 802.11ac. We're certainly glad of this new naming convention.

If your current router is only a few years old, it's likely to be a Wi-Fi 5 model. While Wi-Fi 6 is backward compatible with older devices, you'll need a Wi-Fi 6 router to benefit from the full potential of the new technology.

© GETTY IMAGES

WHEN'S IT COMING OUT?

Earlier this year, a Wi-Fi 6 certification program was announced for devices to support the new standard, stating that products need to offer several features and meet certain criteria to be Wi-Fi 6 certified, with the program starting in the third quarter of 2019—which is pretty much now.

In fact, Wi-Fi 6 capable devices were on display as early as the Consumer Electronics Show (CES) in Las Vegas in January of this year, and you might have noticed that some Wi-Fi 6 routers have already gone on sale—including the Netgear Nighthawk AX8 and AX4, TP-Link's Archer AX6000, and the Asus RT-AX88U. These early devices generally still have the 802.11ax labeling, though.

Does that mean you can go out and buy a Wi-Fi 6 router today? Well, not quite. These early routers are based on the draft standard of Wi-Fi 6, which at the time of their release has not been finalized. If certain aspects of the certification change, then these early routers may miss out on features that other Wi-Fi 6-certified devices boast. As always with early adopters, it's a risk you'll have to take if you want the new technology as soon as possible.

WHAT DO I NEED FOR WI-FI 6?

Of course, having a Wi-Fi 6-capable router is only the first step toward benefitting from the new technology. While your older Wi-Fi products will be able to connect to a Wi-Fi 6 router, to get the features of Wi-Fi 6 (which we'll get to in a moment), you'll also need Wi-Fi 6-certified devices. And at the moment, those are rather thin on the ground.

The good news, though, is that we should start seeing a steady stream of Wi-Fi 6-enabled devices hitting the market. Most flagship smartphones will feature the technology—for example, the Samsung Galaxy S10 is the first smartphone with Wi-Fi 6 built in. At the moment, Wi-Fi 6 could be confined to the more expensive handsets, but hopefully that will quickly change as Wi-Fi 6 adoption grows.

We should also see numerous Wi-Fi 6 laptops coming to the market in the near future, with major manufacturers announcing Wi-Fi 6-equipped notebooks back at CES.

WI-FI 6 SPEEDS

Wi-Fi 6, like other leaps in Wi-Fi technology, brings improvements to both the speed and coverage of wireless networks, but what kind of speeds should we expect from Wi-Fi 6? Early figures suggest that we could see speed boosts of around 30 percent over Wi-Fi 5.

That's a pretty decent improvement, and Wi-Fi 6 should theoretically offer speeds of up to 10Gb/s. While that's still not enough to challenge wired networks, you could see a decent jump in speeds if you're upgrading from Wi-Fi 5.

Asus has already launched a number of Wi-Fi 6 routers.

Wi-Fi 6 will achieve these speeds by fully utilizing the 2.4GHz and 5GHz bands at the same time. By combining the bands, rather than keeping them separate, as in previous Wi-Fi generations, and using MU-MIMO to increase the capacity of the network, Wi-Fi 6 could be a seriously tempting upgrade for anyone who's frustrated with the sluggish performance of their Wi-Fi network. The improved MU-MIMO (multi-user, multiple input, multiple output) features of Wi-Fi 6 will allow eight users on both up and downlink (Wi-Fi 5 only allows four users at once on the downstream). However, there are rumors that this feature may not be present at launch—another reason why early adopters might be wiser to wait until Wi-Fi 6 is more established.

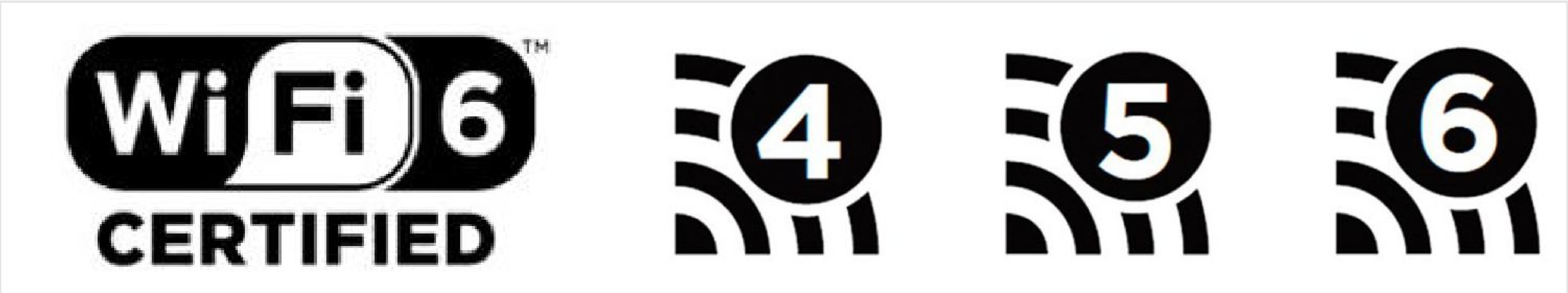
Wi-Fi 6 will also eventually make use of the 1GHz and 6GHz bands when they become available, and the widening of the spectrum will allow for more bandwidth, which can then be split into sub-channels, smartly routing connections between devices for better speeds.

Because of this, people who use Wi-Fi 6 in congested environments—for example, households with lots of different Wi-Fi-enabled devices all vying for an Internet connection—will likely see the biggest leap in performance.

With the number of smart devices in our homes (which require an Internet connection) constantly increasing, Wi-Fi 6 could be a real game changer—quite literally, if you have a house full of *Fortnite* addicts.

It's not just in your home that Wi-Fi 6 can help with congestion, however. If you live in a street or apartment complex with a lot of competing wireless networks, some of the clever technology introduced with Wi-Fi 6 can help reduce conflicts with your neighbors' wireless networks.

One such technology is BSS (Base Service Station) Color. This identifies and marks frames from neighboring networks that don't originate from your household, allowing your router to



Look for the above logo for Wi-Fi 6-certified hardware. The Wi-Fi Alliance has simplified Wi-Fi naming conventions in general.

Netgear's excellent Orbi routers are getting a Wi-Fi 6 upgrade.

effectively ignore them. It's a rather elegant way of ensuring that signals from nearby networks don't interfere with each other.

BANDS ON THE RUN

The fact that Wi-Fi 6 should in the future make use of additional bands alongside 2.4GHz and 5GHz is big news. For what seems like ages, many routers have been providing those two bands. The problem is, 2.4GHz has long been overcrowded with consumer electronics, as so many older or budget devices use that band. Meanwhile, 5GHz isn't just getting more crowded as more devices are released that use that band, but its spectrum is too limited to support wider bandwidth channels. Not only that, but parts of the 5GHz spectrum are still restricted in how they are used.

This has lead to many manufacturers pushing to expand the number of bands available for Wi-Fi devices, with a proposal by some of the biggest names in networking suggesting that the 6GHz band would be "essential to meeting demand for the next generation of wireless broadband services." Fans of wordy, overly technical documents can read the entire proposal at http://bit.ly/6GHzProposal. The bottom line is that Wi-Fi networks need more space. If you think of networks as roads, the more data (vehicles) there is, the more congested they become. Adding additional bands would be similar to opening up more lanes on a highway, to allow traffic to pass more easily.

It looks as though, with Wi-Fi 6, those demands for more bands will be met. This could be one of the most important changes the new technology ushers in—particularly because of our increasingly congested wireless networks. So, while there will

TP-Link and D-Link have both announced Wi-Fi 6 routers.

© TP-LINK, D-LINK, NETGEAR

WI-FI 6 ROUTERS

All the big router manufacturers have Wi-Fi 6 routers available already, or are due to launch them imminently. For example, Asus's RT-AX88U is the company's first Wi-Fi 6 router. It's dual-band and offers up to 6,000Mb/s of Wi-Fi throughput, along with four antennas, and eight LAN ports. It costs $342.

Asus also has the gaming-oriented ROG Rapture GT-AX11000, a tri-band router that can keep one 5GHz band dedicated to gaming, and costs $450. There's also the Asus AiMesh AX6100 Wi-Fi System, which is a mesh Wi-Fi system that can cover the whole home. It should launch around the time you read this issue.

As one of the biggest names in networking, it's no surprise that Netgear is going all-out on Wi-Fi 6, and the company has a number of Wi-Fi 6 routers already available. The Netgear Nighthawk AX8 (RAX80) offers eight streams of wireless connectivity, 160MHz channel support, and 6,000Mb/s throughput over two bands. It also looks like something you'd expect a Sith to fly around in. It's available now for $400.

The Netgear Nighthawk AX12 (RAX120) ups the ante with 12 Wi-Fi streams, plus Alexa and Google Assistant support, and Netgear claims it's the most powerful router the company has ever produced. It is also available now for around $400.

Netgear is also updating its excellent Orbi mesh Wi-Fi system to support Wi-Fi 6, which the company claims will offer gigabit speeds across the entire mesh network, with the ability to handle 12 streams at once, along with MU-MIMO and OFDMA support, and will launch in September.

D-Link was early to the Wi-Fi 6 game, launching a number of devices back in 2018. It's also got a new Wi-Fi 6 router, the D-Link DIR-X6060, which is due to launch some time in 2019.

TP-Link has a few Wi-Fi 6 routers, too, including the Archer AX6000 (available now for $350), Archer AX11000 Tri-Band Wi-Fi Gaming Router (available for $450), and the Deco X10 Mesh Wi-Fi System, which is due to launch late 2019.

As you'd expect, Netgear is pushing Wi-Fi 6 hard.

be an improvement in speeds with Wi-Fi 6, it seems as though the bigger focus with the new technology is making sure that Wi-Fi networks have enough capacity to support the demands of modern connected homes, where every smart device needs a fast and stable Internet connection.

Plus, with home broadband speeds getting ever faster (for those of us lucky enough to live in areas with decent infrastructure, at least), there's an added pressure to ensure that our Wi-Fi networks don't become bottlenecks for ultra-fast fiber broadband.

EXPANDING COVERAGE

Another key advantage of Wi-Fi 6 will be expanding the coverage of Wi-Fi networks. For anyone who's had to put up with a wireless network that struggles to reach certain parts of the home, this will be good news.

One way that Wi-Fi 6 is improving coverage is with beamforming. While Wi-Fi 5 also boasted beamforming functionality, it could only support four antennas, while Wi-Fi 6 can support eight. Beamforming essentially directs Wi-Fi signals toward specific devices in various places, ensuring that those devices get the best possible connection to the wireless network. This is particularly important for devices that move around a lot—such as smartphones and tablets, which are carried around your home.

Wi-Fi 6 can also offer wider coverage (and greater stability) thanks to its longer OFDM symbol. Now, this gets a bit technical, but OFDM is a way of transmitting data by dividing it among smaller sub-carriers. With Wi-Fi 6, the OFDM symbol is four times longer, which means there are four times as many sub-carriers, increasing both coverage and speed. To cut a long story short (and skip over a lot of jargon), it should mean that a Wi-Fi 6 network will reach Wi-Fi 6 devices over a much wider area, such as multiple floors in a house, while remaining fast and stable.

Wi-Fi 6 is also more efficient thanks to OFDMA (Orthogonal Frequency-Division Multiple Access), which is brand new for Wi-Fi 6, although the technology has been used in 4G LTE networks. Essentially a multi-user version of OFDM, it allows

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© SAMSUNG

We hope to see Wi-Fi 6 laptops soon as well.

WI-FI 6 SMARTPHONES

You can have any brand of Wi-Fi 6 smartphone… as long as it's Samsung (for now).

If you're after a Wi-Fi 6-enabled smartphone, your choices at the moment are pretty limited. Basically, you'd better like Samsung phones. The Samsung Galaxy S10 family of smartphones were the first handsets to support Wi-Fi 6, and this includes the Galaxy S10, S10 Plus, and the (slightly) more affordable Galaxy S10e. Meanwhile, the Galaxy S10 5G offers both Wi-Fi 6 and 5G support, making it the best smartphone if you want to experience the latest network technology. These phones don't come cheap, however. The S10 costs $899 for the 128GB model, and features a 6.1-inch QHD+ screen, 8GB of RAM, and a triple-lens rear camera, with a 12MP regular lens, 12MP optically zoomed telephoto lens, and a new 16MP ultra-wide lens. Meanwhile, the S10 Plus costs a huge $999 for the 128GB version, and packs a 6.4-inch QHD+ screen, 8GB or 12GB of RAM, and that same triple-lens camera. Even the supposedly more affordable Galaxy S10e is still a very pricey proposition at $749 for the 128GB version, which comes with 6GB of RAM, a 5.8-inch 1080p screen, and dual-lens camera. As Wi-Fi 6 adoption grows, we should see a wider range of smartphones from a variety of manufacturers being released with Wi-Fi 6 support, and we hope that the new Wi-Fi technology won't be confined to ultra-expensive flagship smartphones either—we'd love to see it appear on more affordable handsets. At the time of writing, Apple has just released its new iPhone 11 smartphones, and while there were rumors circulating that the handset will feature both 5G and Wi-Fi 6 connectivity, it turns out that this generation wasn't ready for 5G just yet. They do support Wi-Fi 6 though—great news if you're not a fan of Android. While smartphone manufacturers are understandably more excited about 5G support than Wi-Fi 6, our phones are probably the devices we use the most to connect to Wi-Fi networks, so we hope they embrace the new technology with future handsets.

up to 30 clients to share a channel (rather than waiting for the channel to become available), and can combine different types of network traffic. Router maker TP-Link explains the technology by comparing Wi-Fi connections to a series of delivery trucks that deliver data packets to your devices. In previous versions of Wi-Fi, these delivery trucks could only deliver one parcel to one device at a time. However, with Wi-Fi 6 and OFDMA, each truck can deliver multiple parcels to multiple devices simultaneously. In the real world, this would certainly speed up Amazon deliveries, but in the case of Wi-Fi 6, it leads to more efficient data delivery, and could help boost the speeds of uploads and downloads.

BETTER BATTERY LIFE

You might not realize it, but how your device connects to Wi-Fi networks can be one of the biggest drains on its battery life, and with Wi-Fi 6, the Target Wake Time (TWT) feature makes this more efficient. It helps control when mobile devices wake up to send and receive wireless data, and by better managing this, those mobile devices can remain in their sleep state for longer. This, in turn, leads to noticeably longer battery lives for your mobile devices.

This technology will also benefit low-powered Internet of Things (IoT) devices. With our homes becoming ever more packed with this kind of smart gadget, this is good news.

SHOULD YOU BE EXCITED?

For many people, Wi-Fi is something that's always there and, most of the time, just works, so it can be difficult to get excited about it. However, there are some scenarios where Wi-Fi 6 can really make a difference. If you live or work in an area with a lot of competing wireless networks, or your home is full of devices (and people) all hammering the Internet, Wi-Fi 6's increased speeds and bandwidths can be a real bonus. Plus, as our homes become ever more connected with an increasing number of smart devices, while we also demand more from our networks and Internet connections, thanks to 4K streaming (and upcoming game streaming services such as Google Stadia will add to that strain), Wi-Fi 6 will seem ever more essential. ⏻

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Few smartphones support Wi-Fi 6, but we hope that changes soon.

© NETGEAR

INDUSTRY PERSPECTIVE

Why should we get excited about Wi-Fi 6? We chatted to Lionel Paris, Director of Product Marketing, Consumer Products, at Netgear, about how Wi-Fi 6 can upgrade our home networks.

"Wi-Fi 6 is exciting in a number of ways. Although Wi-Fi has been around for 20 years, understanding it has always been a challenge for consumers. This year, the Wi-Fi Alliance has answered the need for clarity by using numbers (4, 5, and 6) to differentiate Wi-Fi generations. It's a lot easier to understand the step up from Wi-Fi 5 to Wi-Fi 6 than 802.11ac to 802.11ax, so we're really pleased about that progress. Not only that, but it will help with educating consumers on the different speeds and versions available, to ensure that when it's time to upgrade, they'll know they are buying the latest standard.

"As you might expect, Wi-Fi 6 brings major improvements in both speed and coverage. While each improves up to four times, of equal importance is that the new standard is much better equipped to deal with the modern home full of connected devices. With the average UK home predicted to have 50 connected devices by 2023, it's crucial to bring in a standard that has the capacity to deliver great performance under increasing demand."

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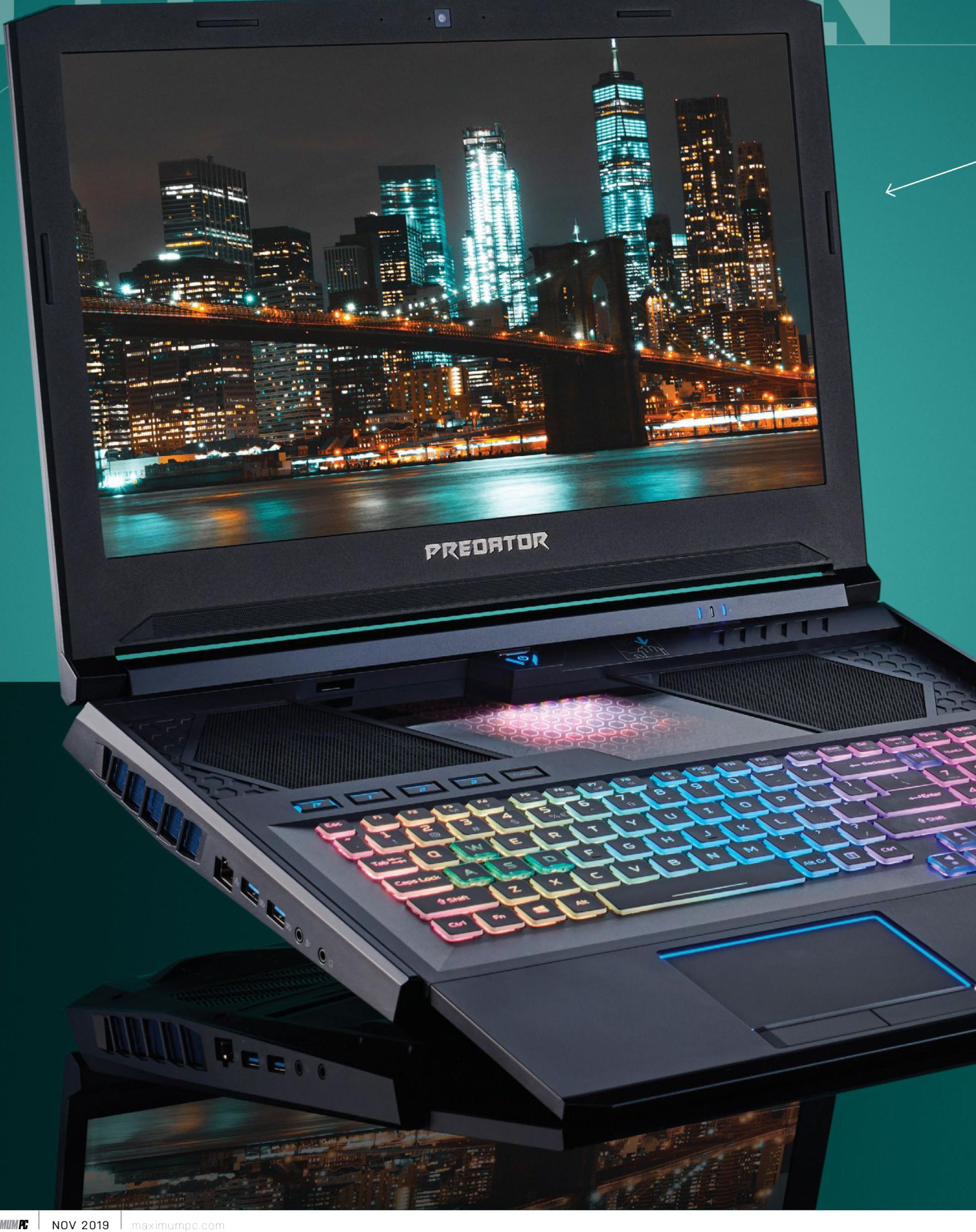
TECH PORN



1 SCREEN QUEEN

The 17.3-inch screen is as clear as crystal, with a crisp 144Hz refresh rate at 1080p, and support for Nvidia's G-Sync. Outputting video is dead simple, too—hidden at the rear of the chassis are both a DisplayPort and an HDMI port, prepped to handle multiple monitors as part of a home or work setup.

Acer Predator Helios 700

THIS MIGHT JUST BE THE MOST ridiculous laptop we've ever had the (mis?)fortune of handling. And yet we love it; the Predator Helios 700 is one of the beefiest gaming laptops we've come across, packing a ninth-gen Intel Core i9 processor, and up to 64GB of RAM. It feels like something we'd use to launch a drone strike from the security of an armored bunker. But the key aspect of this machine, as you've probably figured, is the sliding keyboard. It slips down the chassis with ease, trackpad folding down to form a wrist rest, exposing what Acer calls the "vapor chamber."

This additional cooling method enables the Helios 700 to hit overclocking figures that were previously inaccessible to even the most powerful gaming laptops. The CPU has no difficulty reaching 5GHz, even before we started to meddle around with fan speeds. It looks great, too, with a hexagonal pattern over the vapor chamber that can be illuminated to your liking, and some tasteful blue LED lighting on the back of the display.

The keyboard feels sturdy and pleasing to use, with every single key individually addressable using Acer's PredatorSense software. The WASD keys also utilize Acer's patented linear switch technology to sense variable force input, enabling joystick-like precision in games. There's also a button to engage "turbo overclocking," and three mappable keys that can be switched between three color-coded modes, making for nine potential functions reachable with just a press or two. You can even set up your own macros to run instantly with these buttons. **–CHRISTIAN GUYTON**

2 STAY FROSTY

The vapor chamber is equipped with two high-speed fans, one for the processor and one for the GPU. Just visible underneath an RGB-lit panel of reinforced glass are five copper heat pipes, expertly dissipating excess heat. Those fans can get mighty noisy when overclocking, but this system can definitely handle the heat.

3 HIGH POWERED

Our model came with an i9-9980HK and RTX 2080 GPU—none of that Max-Q nonsense. The Helios 700 is bulky enough to fit a full-scale 2080 inside, and it shows; it has no difficulty running triple-A games at maximum graphics, performing brilliantly with its auto overclocking functions enabled.

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```
#!/usr/bin/env python3
# Python intro 2018

def main():
    print('Hello world')

def loop():
    for j in range(5):
        print(j)

if __name__ == '__main__':
    main()
```

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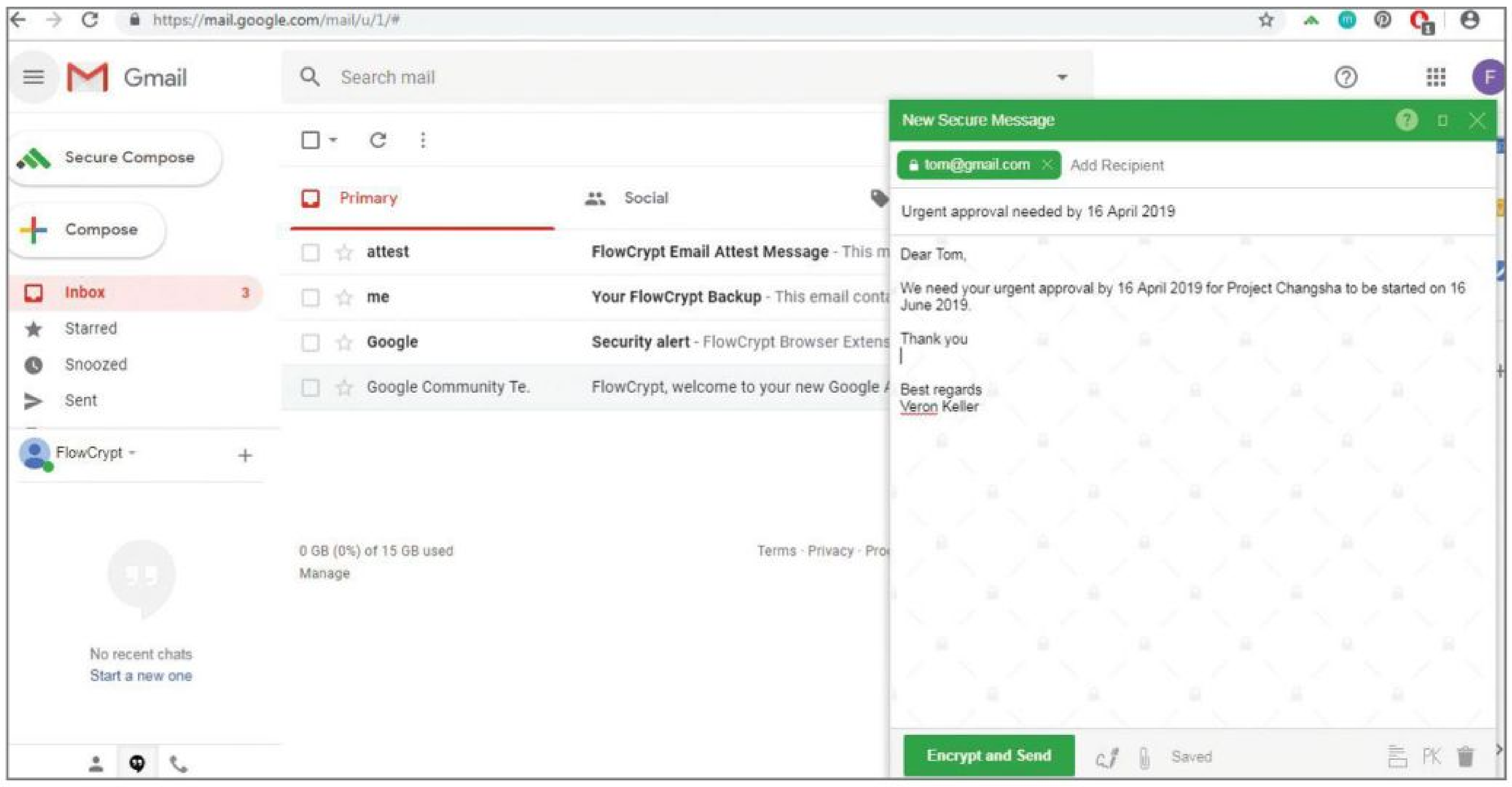
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH


https://mail.google.com/mail/u/1/#
Gmail
Search mail
Secure Compose
Compose
Inbox 3
Starred
Snoozed
Sent
FlowCrypt
Primary
Social
attest
me
Google
Google Community Te.
FlowCrypt Email Attest Message - This m
Your FlowCrypt Backup - This email conta
Security alert - FlowCrypt Browser Extens
FlowCrypt, welcome to your new Google A
0 GB (0%) of 15 GB used
Manage
Terms · Privacy · Pro
No recent chats
Start a new one
New Secure Message
Add Recipient
Encrypt and Send
Saved
PK

tom@gmail.com

Urgent approval needed by 16 April 2019

Dear Tom,

We need your urgent approval by 16 April 2019 for Project Changsha to be started on 16 June 2019.

Thank you

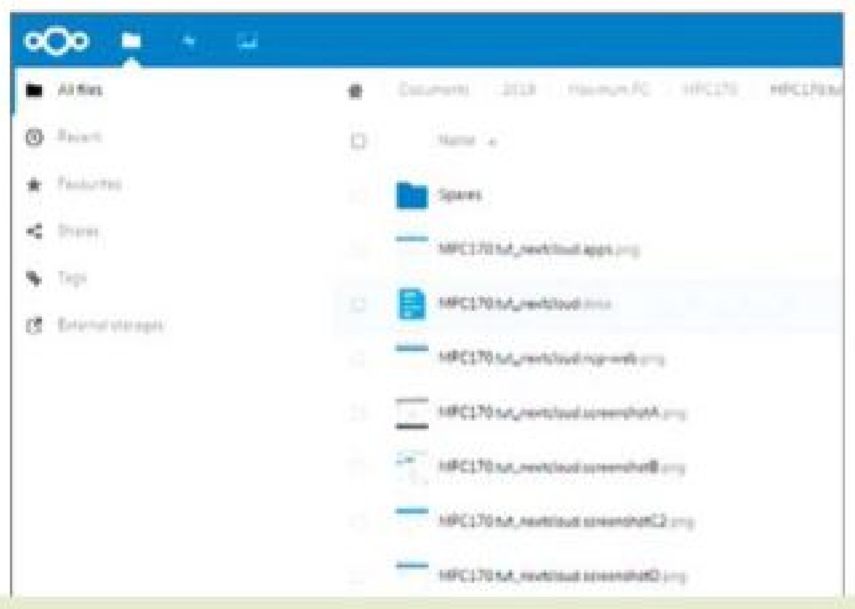
Best regards
Veron Keller

© FLOWCRYPT

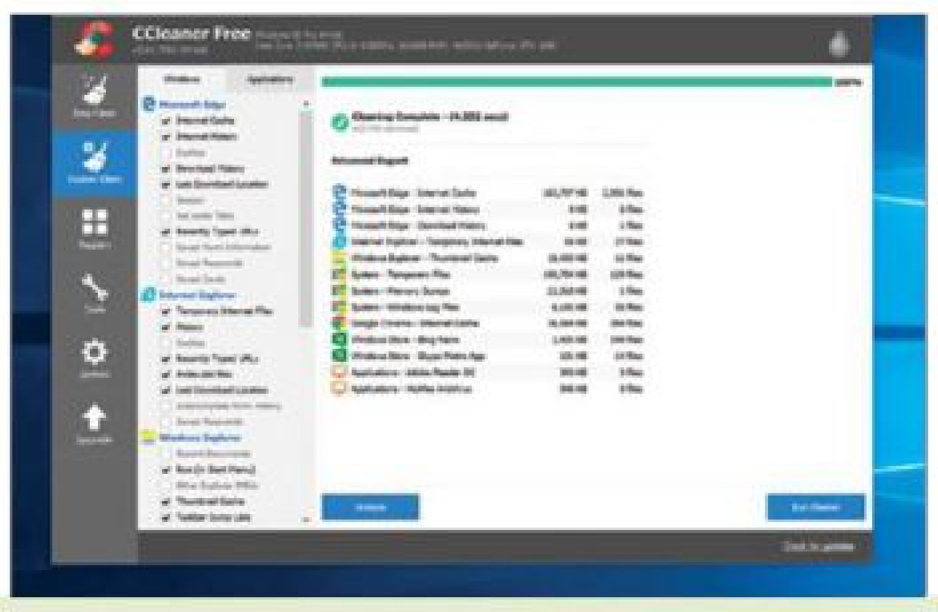
SECURE YOUR EMAILS WITH FLOWCRYPT

Another nifty Chrome extension, FlowCrypt seamlessly adds new security functions to Gmail, most importantly a "Secure Compose" button that lets you craft encrypted emails with ease. You can also include a personalized public key, which enables people who don't use FlowCrypt to reply to your emails with consistent encryption. If you don't use Chrome, it's available on other platforms, too, including an Android app.

MAKE – USE – CREATE



56
Set up your own NextCloud server on a Raspberry Pi



62
Free up some valuable storage space on your SSD

70
A GeForce RTX 2070 Super-centric 1440p gaming rig for $2,000

CHRISTIAN GUYTON
STAFF WRITER

M.2 WOES

It was easy to get caught up in all the excitement surrounding NVMe Gen4, and the associated transfer speed boosts to our M.2 drives. The new drives were fast as hell, and I'm certainly guilty of squirming in joy when I saw our benchmarking software hit that legendary 5,000MB/s read speed. The write speeds are almost as impressive, making these drives ideal for anyone regularly moving large quantities of data around.

Unfortunately, read/write speeds aren't all that matters with SSD performance. The PCIe 4.0 format has a theoretical maximum transfer speed of 8GB/s across a quad-lane interface, and the new drives aren't hitting those figures. There's plenty of unused headroom, although it's early days for the new M.2 drives. Hopefully, we'll see SSDs taking full advantage of the potential of PCIe 4.0, although there are other problems to consider.

High-speed SSD writing is great for downloading and saving large files, but there are other places where your system could bottleneck; Internet speed being the main example. Heat management is a problem, too; transfer a massive bulk of files, and you'll see performance drop as the drive heats up, particularly if you don't have a drive heatsink. Manufacturers have a way to go before the M.2 format is perfect.

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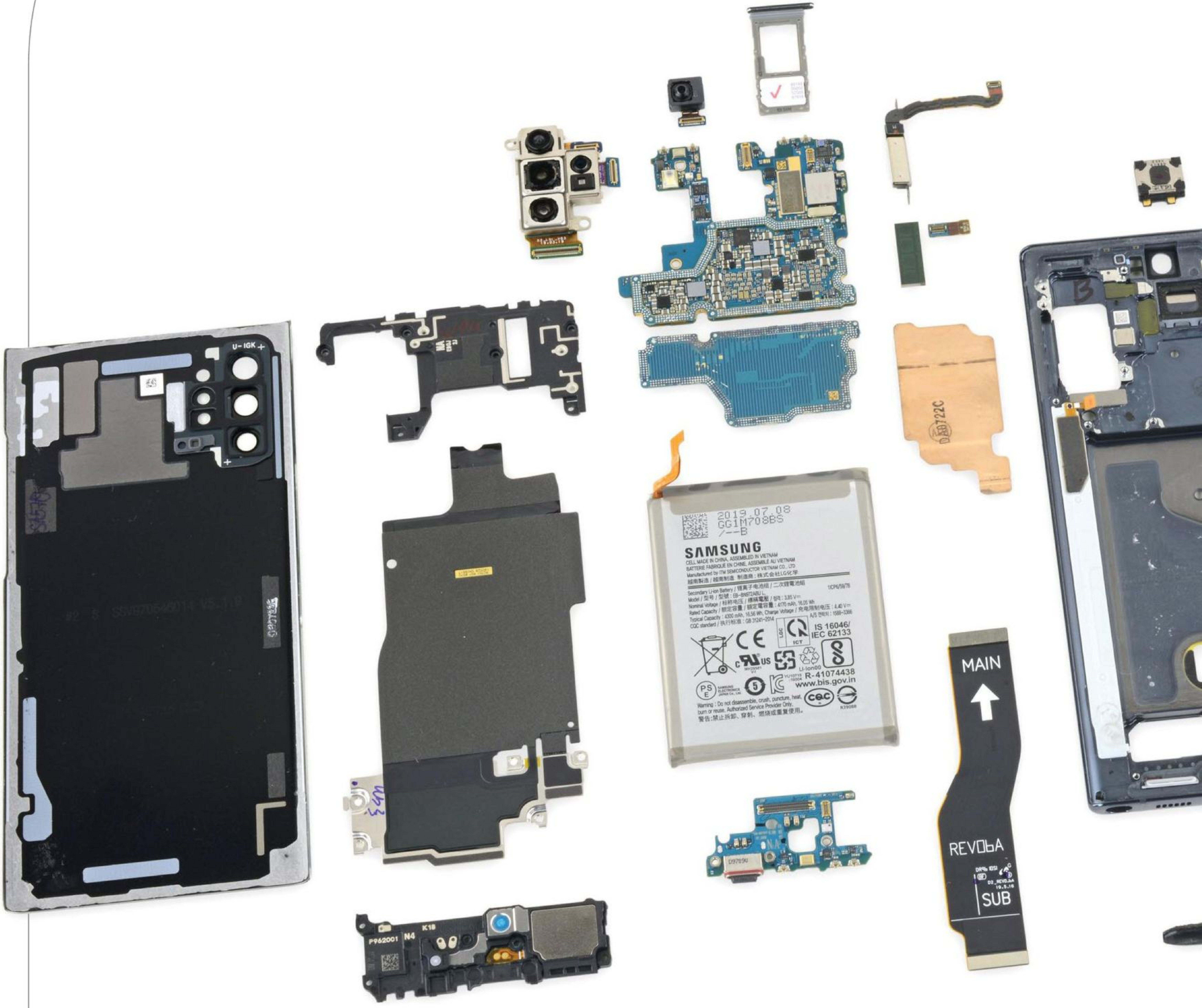
IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Samsung Galaxy Note10+ 5G


SAMSUNG
2019 07 08
GG1M708BS
MAIN
REV06A
SUB
P962001 N4 K18

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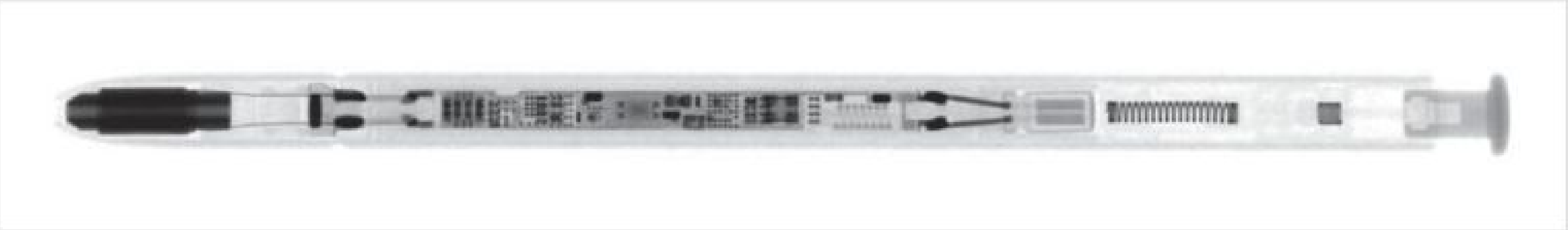
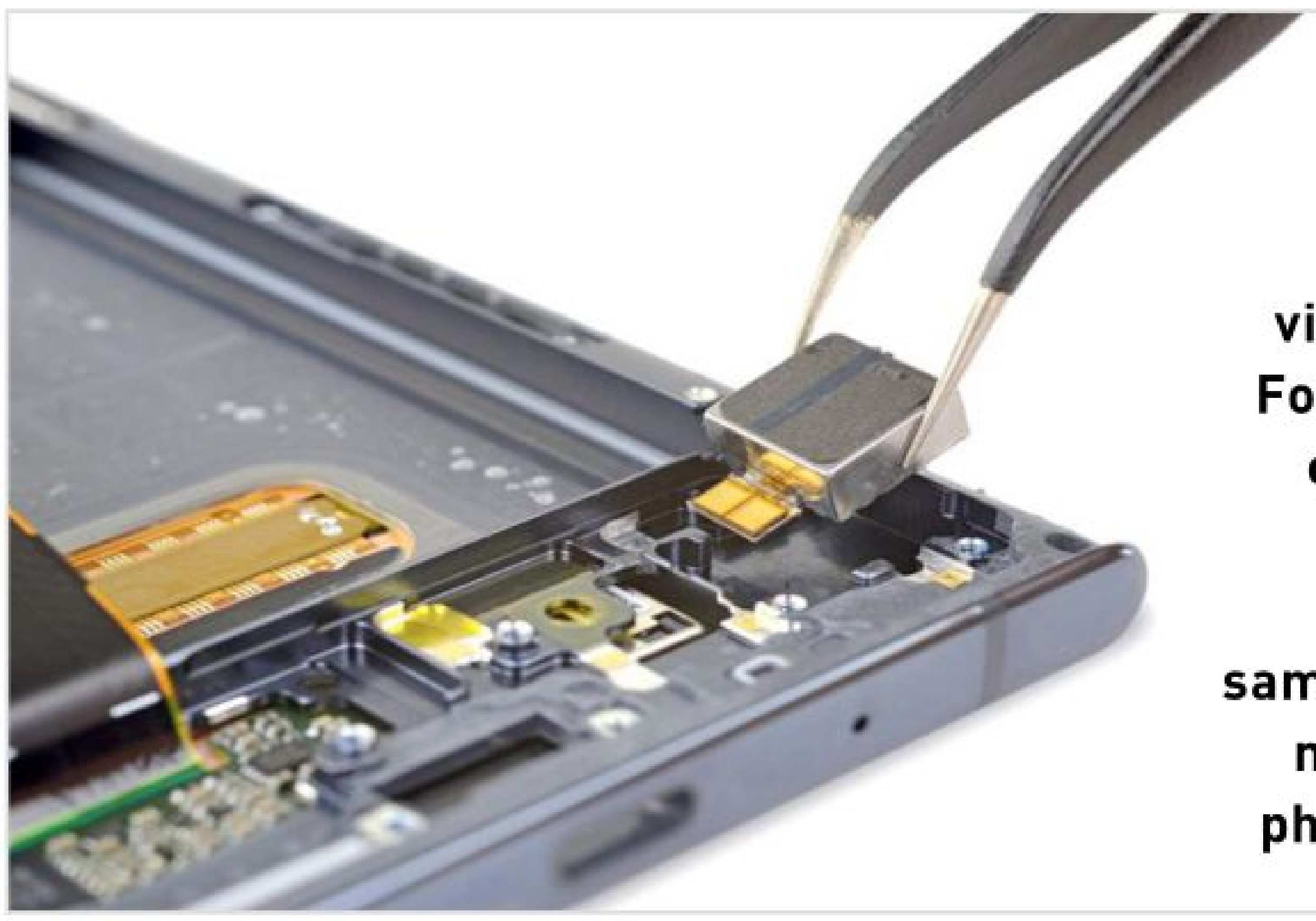
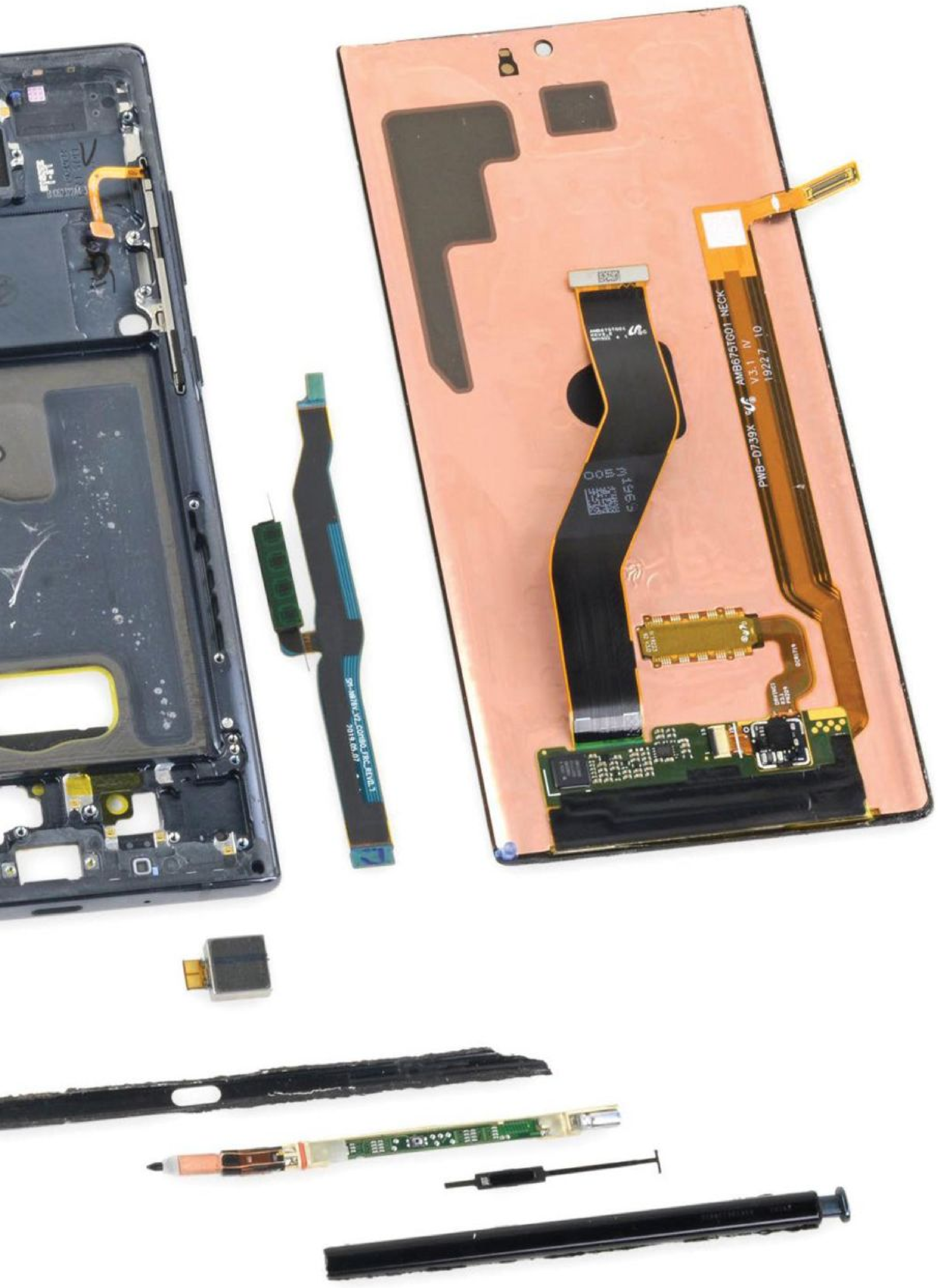
The new and improved S Pen, now with gesture control, for wizard-like wireless control of your Note10.





A square-ish vibration motor! For as long as we can remember, Samsung has employed the same circular LRA motor for all its phones' buzzers.



BACKGROUND

Samsung's penned the death of the headphone jack with its newest phablet, the everything-but-the-kitchen-sink Galaxy Note10+ 5G, but what does lie within that monolithic slab?

MAJOR TECH SPECS

- 6.8-inch AMOLED Infinity-O display with 3040×1440 resolution (498 ppi), HDR10+ certified
- Qualcomm Snapdragon 855 paired with 12GB RAM and 256GB internal storage
- 4,300mAh battery
- Four rear-facing cameras (16MP ultra-wide, 12MP wide-angle with OIS, 12MP telephoto with OIS, VGA DepthVision camera), plus a 10MP selfie cam
- Ultrasonic in-screen fingerprint sensor
- S Pen stylus with Bluetooth connectivity and 6-axis sensor
- IP68 dust and water resistance rating

KEY FINDINGS

- As we slice away at the adhesive, we notice that the cover is contoured around the volume and power buttons. A few Phillips screws hold down the midframe assembly—nothing our tried-and-true Mako 64-bit kit can't handle!
- With the midframe removed, we encounter a radical change: the motherboard is solely at the top of the device, Pixel-style. While this allows for a wider battery, it makes the connection between mother and daughterboard trickier, necessitating annoying interconnect cables that block battery access. Our trusty iSclack gives some solid leverage on the battery, but it still takes a lot of isopropyl alcohol before the adhesive surrenders. If we called the Note9's 15.4Wh battery "ludicrous," the Note10+'s 16.56Wh powerhouse must be "plaid." We jettison the SIM tray and release the mobo, along with the five cameras.
- Looks like Samsung stacked its motherboard for maximum space savings, but we quickly separate the boards. The daughterboard comes out without a fuss, bringing the soldered-on USB-C port and lower microphone in tow. Soldered-on isn't our favorite flavor of USB-C port, but at least there isn't much on this board, so replacements shouldn't be too expensive.
- The earpiece speaker looks ordinary, except that it's trapped behind the screen. How do the songs get out? The speaker actually fires into a shallow metal chamber, which channels the sound waves into the tiny grille along the top edge of the frame. After some tedious heating and prying, we get to the back of the Samsung-made 6.8-inch Dynamic AMOLED Infinity-O display, the biggest, brightest, most color-accurate display ever on a Note phone. The ultrasonic fingerprint sensor clings to the back of the display, just as it did to the S10.
- Repairability Score: 3 out of 10 (10 is the easiest to repair). Equally-sized Phillips fasteners means you only need one driver for repairs. Many components are modular and independently replaceable, but no more headphone jack means double duty for the USB-C port. Every repair starts with painstakingly ungluing the fragile glass rear cover. Replacing the glued-down battery is tougher than ever, especially with board interconnect cables to work around. All-too-common display repairs require either a complete teardown or replacing half the phone.

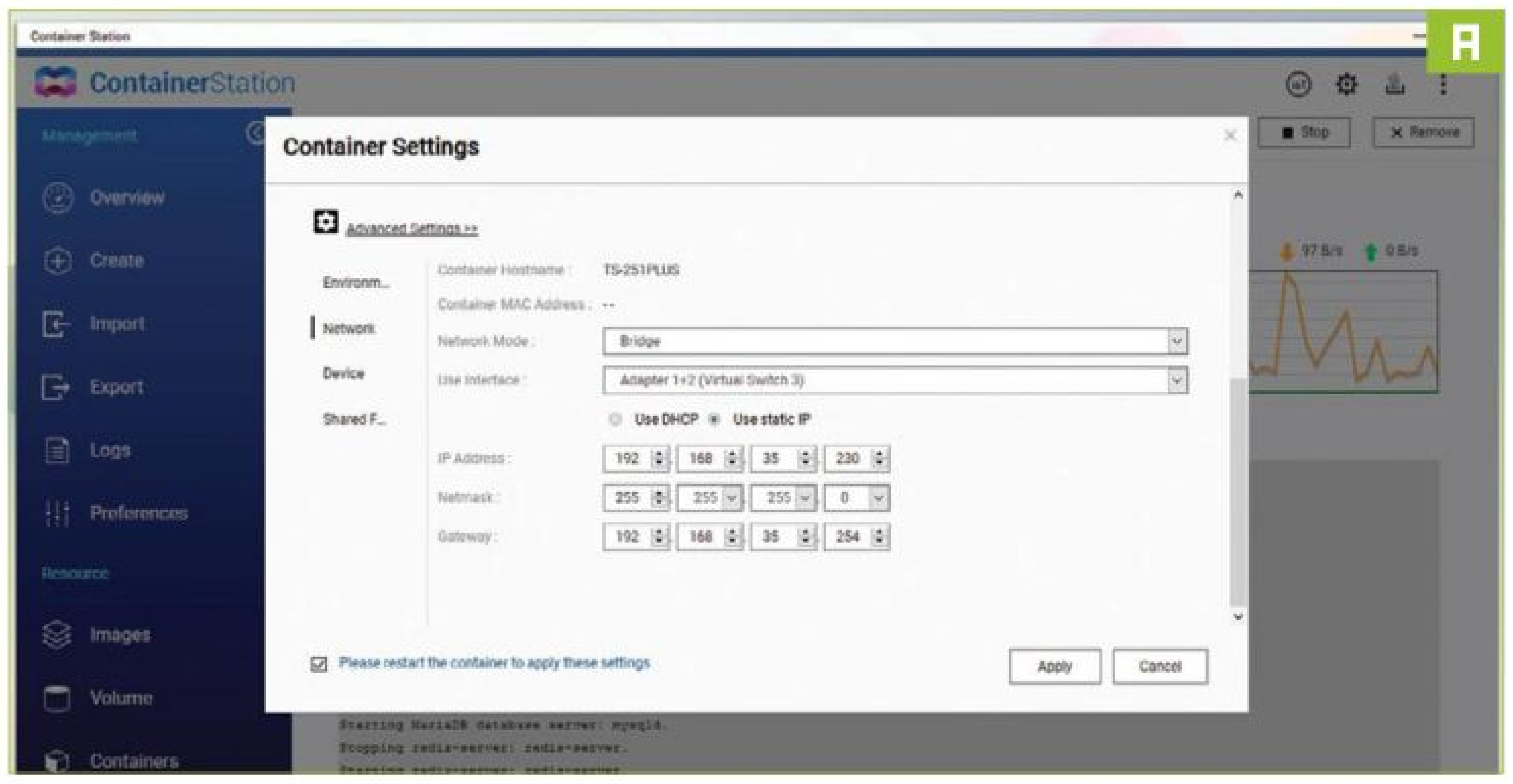
Set Up Your Own NextCloud Server

YOU'LL NEED THIS

NEXTCLOUDPI
Download this preconfigured instance of NextCloud for Raspberry Pi, Debian Stretch, Dockers, and VMs from https://ownyourbits.com/nextcloudpi.

THERE'S ONE MAJOR PROBLEM with cloud storage: Who's in control of your data? Thankfully, NextCloud gives you the best of both worlds—all the functionality found in cloud services such as OneDrive and Google Drive, but crucially your data remains in your possession, distributed among all your devices, and held in your choice of central location, typically a USB drive or network attached storage.

NextCloud runs on a variety of hardware—natively on Linux-based machines, or through Dockers and VMs on other platforms. We've chosen to base this tutorial on NextCloudPi, a dedicated and preconfigured NextCloud instance, with most of the technical work of initial setup and configuration of databases done for you. We installed it on a Raspberry Pi 3B+ for the purposes of this tutorial, paired with a now-discontinued 320GB PiDrive for storage. Performance was a little sluggish—if you can afford it, a brand new Raspberry Pi 4 with at least 2GB of RAM should perform much better. We also successfully tested it on our QNAP TS-251+ NAS using Docker, and have managed—with some tweaking—to get it installed on a PC running Debian Stretch, too. Enough preamble, let's get moving.... –**NICK PEERS**



Container Settings

Container Hostname : TS-251PLUS
Container MAC Address : --
Network Mode : Bridge
Use Interface : Adapter 1+2 (Virtual Switch 3)
○ Use DHCP ● Use static IP
IP Address : 192 . 168 . 35 . 230
Netmask : 255 . 255 . 255 . 0
Gateway : 192 . 168 . 35 . 254

☑ Please restart the container to apply these settings

1 SET UP NEXTCLOUDPI

If you plan to set aside a single Raspberry Pi for NextCloudPi, visit https://ownyourbits.com/downloads/ on your main PC, and open the "RPi" folder. Download ".tar.bz2" and extract the IMG file using a tool such as 7Zip before writing it to an SD card (8GB or larger) using the likes of Etcher (https://etcher.io).

›› To add NextCloudPi to Debian Stretch, use the Terminal:

```
$ su
$ apt-get update && apt install curl
$ curl -sSL https://raw.githubusercontent.com/nextcloud/
nextcloudpi/master/install.sh | bash
```

›› Visit https://github.com/nextcloud/nextcloudpi/issues if you run into any problems.

›› NextCloudPi can also be installed on other systems—including Windows, other Linux distros, plus Synology, and QNAP NASes—through Docker. Search for NextCloudPi using your Docker app, and make sure during the Docker creation process that—if necessary—you ensure it has access to your network in bridged mode [**Image A**].

2 INITIAL SETUP

For the first run, hook up your Pi to a monitor, keyboard, power supply, and—if connecting to a wired network—Ethernet cable. Log into the system using the default pi/raspberry username/password combination.

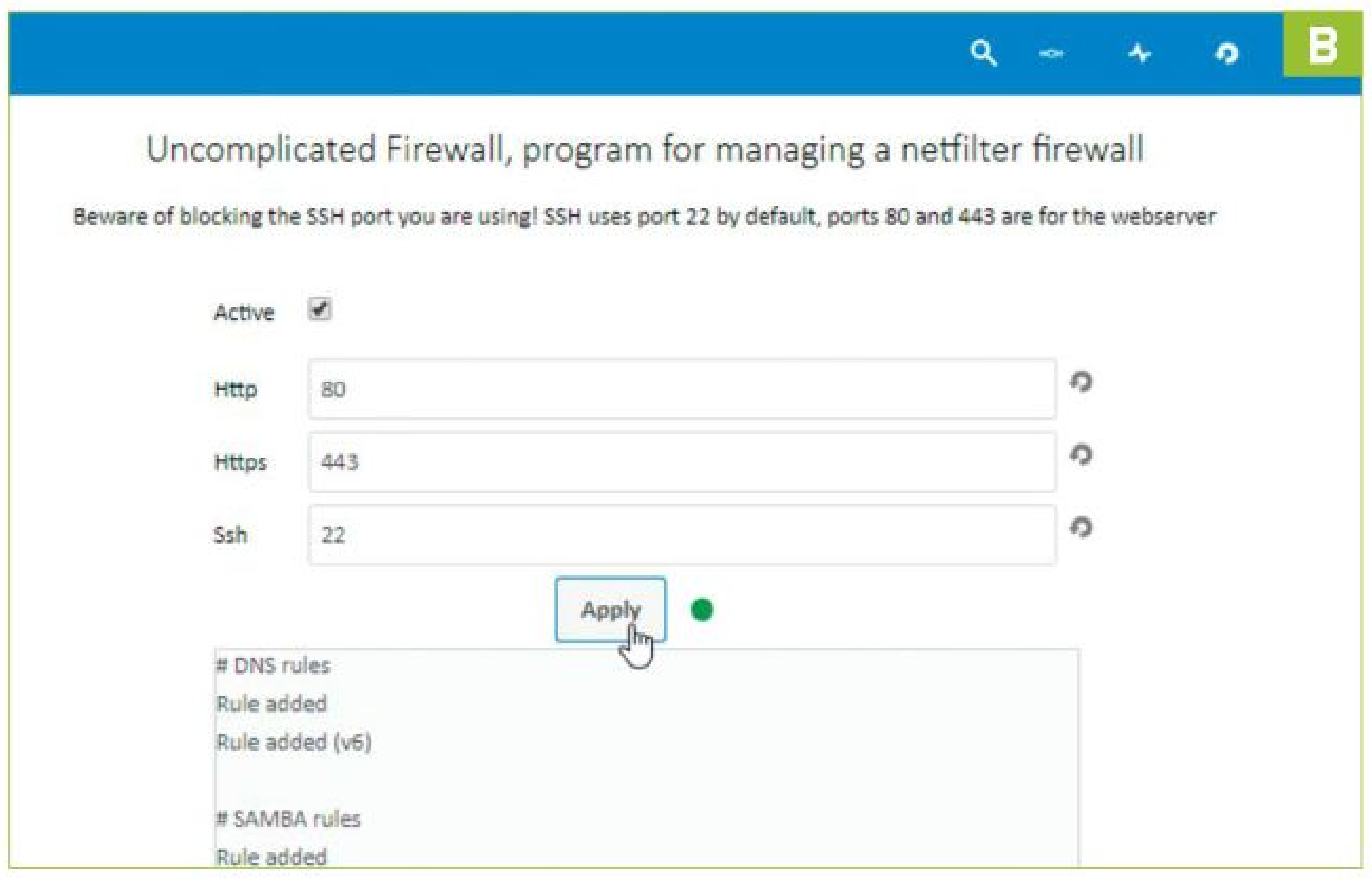
›› If you plan to connect your Pi to the network via Wi-Fi, type `sudo raspi-config` and press Enter. Select "Network Options → Wi-Fi." Follow the prompts to select your country, then enter your network name (SSID) and password. To verify the connection, close raspi-config, then type `ifconfig` and hit Enter to verify your wlan0 settings.

›› Type `sudo ncp-config` and hit Enter to access the NextCloudPi configuration tool. Select "Config," then scroll down and select "nc-webui." Change "ACTIVE again" to "yes" and hit Enter. Ignore the instructions on how to activate the new configuration—this happens when you next reboot. All other configuration can be done through the web interface on another PC. Exit ncp-config, shut down the Pi (`sudo shutdown -h now`), disconnect the monitor and keyboard, then boot up again.

3 FIRST WEB LOGIN AND DRIVE SETUP

Wait for your Pi to get up and running, then open a web browser on another device, and type `https://nextcloudpi:4443` —you're warned about a potential security risk, which is normal with self-signed SSL certificates. Taking Firefox as an example, click "Advanced → Accept the Risk and Continue." You're prompted to enter a username and password—this time, it's "ncp" (username) and "ownyourbits" (password).

›› You're shown the NextCloud Activation screen. Two users are listed here: The first is required to log into the NextCloudPi configuration tool, and the other is the



Uncomplicated Firewall, program for managing a netfilter firewall

Beware of blocking the SSH port you are using! SSH uses port 22 by default, ports 80 and 443 are for the webserver

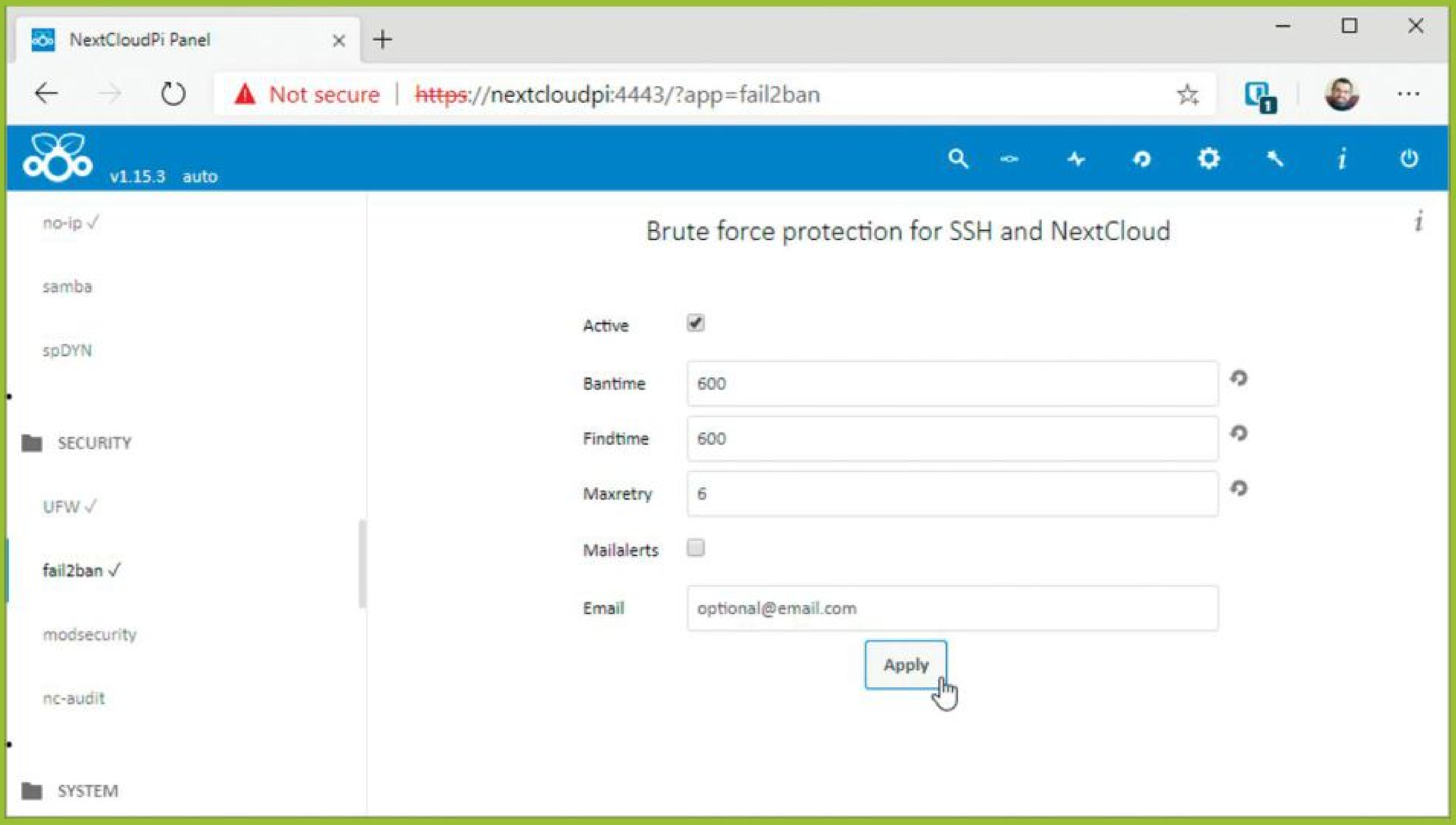
Active ☑
Http 80
Https 443
Ssh 22

```
# DNS rules
Rule added
Rule added (v6)

# SAMBA rules
Rule added
```

© NEXTCLOUD

MORE NEXTCLOUDPI CONFIGURATION



Brute force protection for SSH and NextCloud

Active ☑
Bantime 600
Findtime 600
Maxretry 6
Mailalerts ☐
Email optional@email.com
Apply

Logging into https://nextcloudpi:4443 gives you the opportunity to configure your underlying installation—this can also be done via the Terminal or SSH using the ncp-config tool. Configuration tools are divided into seven sections: Backups, Config, Networking, Security, System, Tools, and Updates.

Start by visiting the "Updates" section. By default, you're alerted to updates to NextCloud and NextCloudPi, but you can configure both to be updated automatically when available. Options for manually updating these and any NextCloud apps are also found here.

Want to store your data on a network drive? Navigate to "Networking → samba" where you'll see instructions for creating a shared folder with access for your NextCloud username and whichever password you specify.

Change your NextCloudPi user password via "Config → nc-passwd" and your NextCloud administrator details via "Config → nc-admin." Want to reset and start over? Do so via "Config → nc-init." Explore the "Backup" section for ways of ensuring your NextCloud configuration is periodically backed up. Finally, look for the "i" button next to any configuration tool—clicking this opens a new tab pointing to the NextCloudPi configuration manual.

default user for NextCloud itself. Two lengthy passwords are generated randomly—you can change these later, but for now note them down or add them to your password manager before clicking "Activate."

›› You're shown the NextCloud Pi First Run wizard. Click "run" followed by the NextCloudPi logo to set up key options. You're asked if you want to save NextCloud data to a USB hard drive. Click "Yes," plug in the drive, and click "Continue." You're given the opportunity to format the drive, which will destroy all data on it. Click "Skip" only if it's already formatted to ext4 or BTRFS and there's data you need to keep. Once complete, click "Move data to USB" to indicate that's where your NextCloud data will reside.

›› The next option allows you to choose whether to have access to NextCloud from outside your home network. Click "No" for now—you can change this later. The wizard finishes by offering you the opportunity for further configuration.

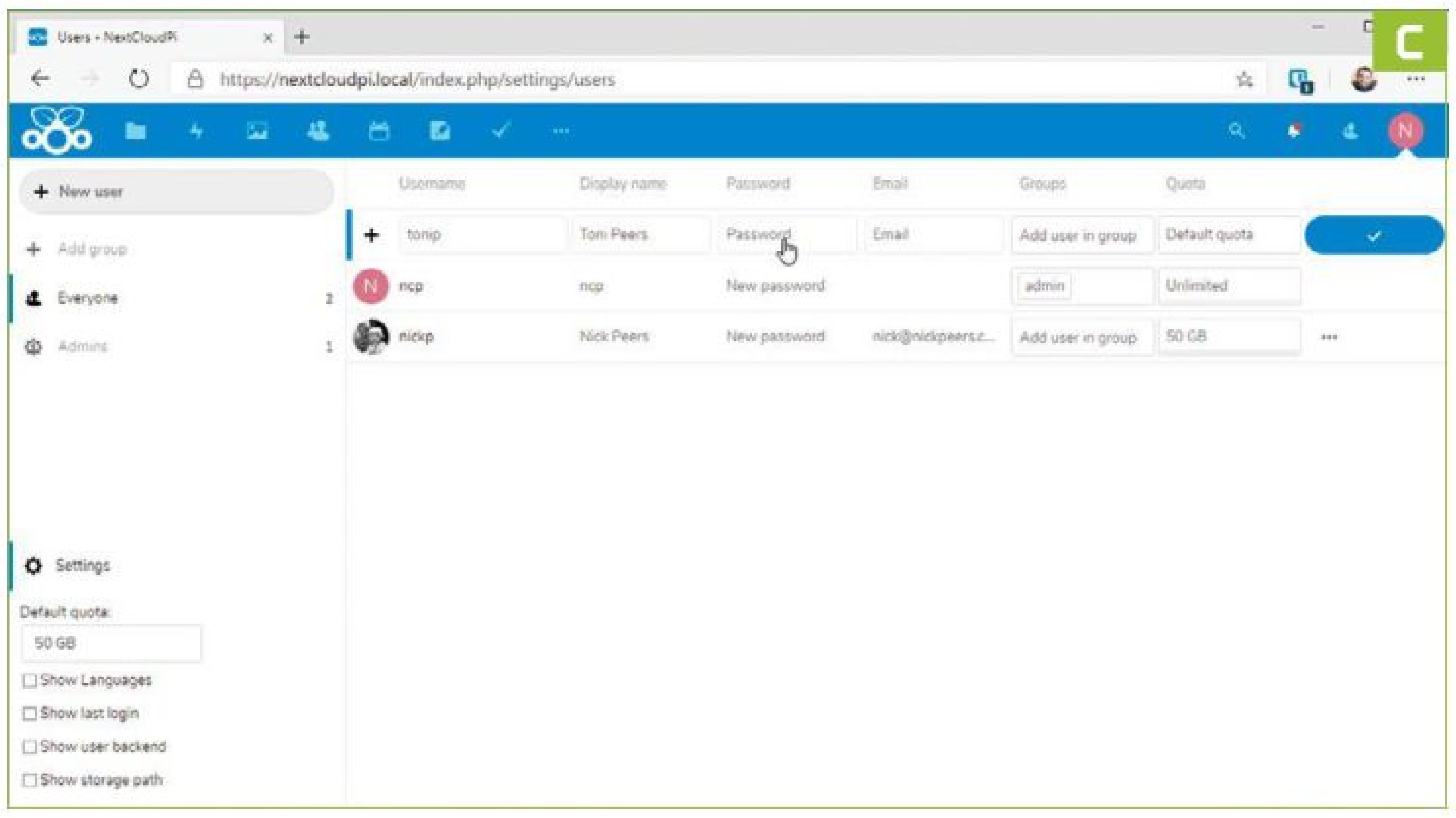
4 OPEN ACCESS TO OUTSIDE YOUR NETWORK

If you want to be able to sync to NextCloud when outside your home network, you need to perform some additional configuration. First, you need a dynamic DNS address to make it easy to reach your server from the Internet. NextCloudPi supports various options, all of which can be seen in the "Networking" section. Select one and visit the URL listed to set up a free account if necessary, then input your details, and click "Apply."

›› Tighten security by applying a free SSL certificate to your new site: Select "Networking → letsencrypt," entering your DDNS domain and an email address. This is only straightforward if NextCloudPi is the sole device on your network with outside access to the Internet through ports 80 and 443. After the certificate is set up, use nc-forward-ports to change ports if necessary.

›› Once in place, you should be able to access the main NextCloud interface via https://domain.name:443 (where domain.name is your DDNS, such as johndoe.ddns.net, and 443 the secure port you designated in nc-forward-ports). You can only access and configure NextCloud itself from the Internet—the NextCloudPi configuration tool is only accessible from inside your network for security reasons.

›› Two final security steps: Under "Security," we recommend enabling UFW (simple firewall) [**Image B**] and fail2ban (protection against brute-force hacking attempts). That's it for NextCloudPi configuration for now—see the box above for more options to look at if you want to keep tweaking.



Username	Display name	Password	Email	Groups	Quota
tonip	Toni Peers	Password	Email	Add user in group	Default quota
ncp	ncp	New password		admin	Unlimited
nickp	Nick Peers	New password	nick@nickpeers.c...	Add user in group	50 GB

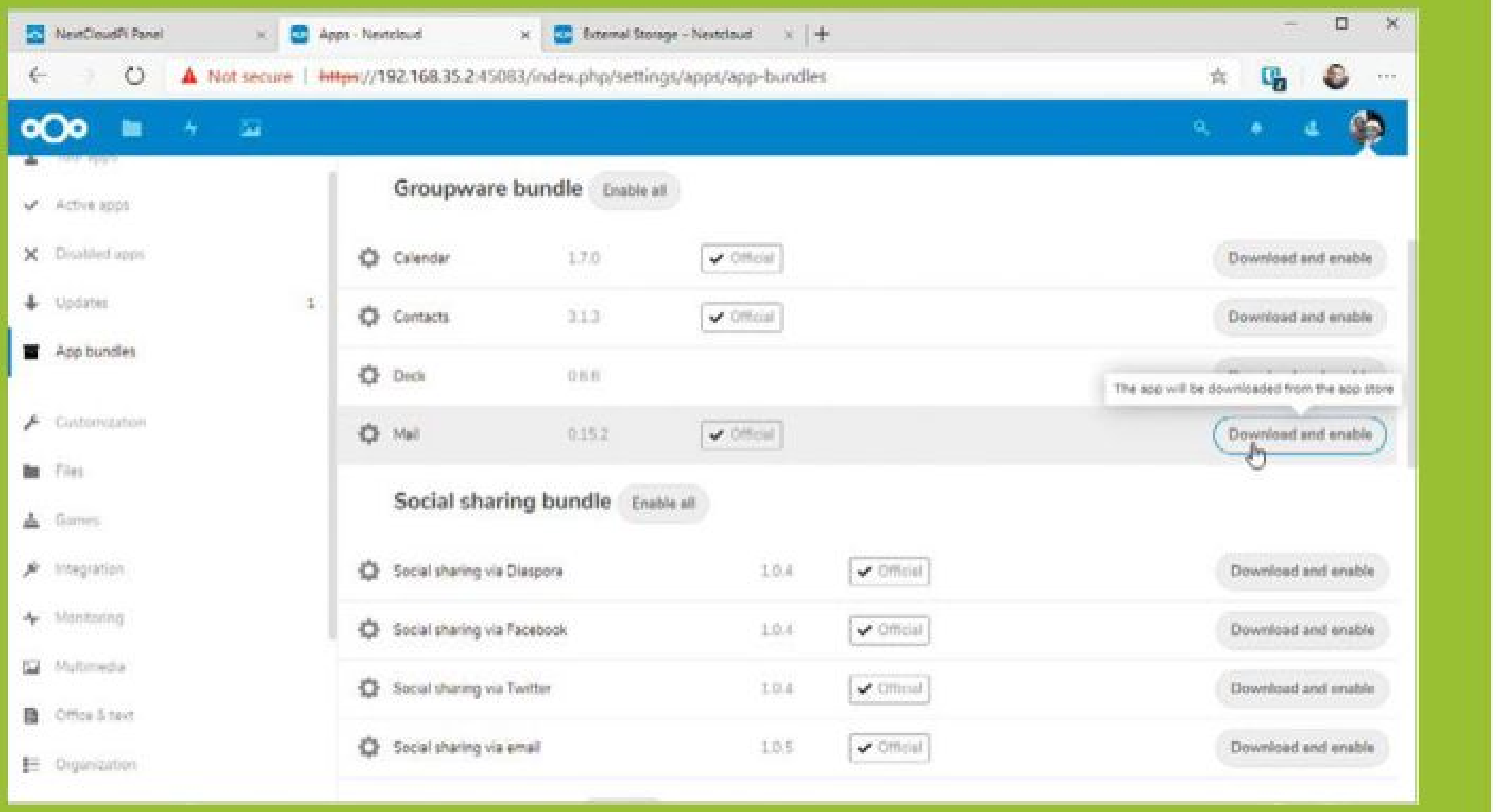
Default quota: 50 GB
☐ Show Languages
☐ Show last login
☐ Show user backend
☐ Show storage path

5 SET UP NEXTCLOUD

At last, it's time to get started with NextCloud itself. To access it from inside your local network, open a new tab and type `https://nextcloudpi.local/` —skip through any security warnings, then enter the second ncp user and password recorded earlier. (Lost it? Switch back to the NextCloudPi config tab, and copy it from "Config → nc-admin.") The first login takes a little while to complete, but eventually you'll find yourself at the main screen.

›› You'll see your new NextCloud user folder is already populated with some example files and two folders

AND THERE'S MORE...



https://192.168.35.2:45083/index.php/settings/apps/app-bundles

Calendar 1.7.0 ✓ Official
Contacts 3.1.3 ✓ Official
Deck 0.6.6
Mail 0.15.2 ✓ Official
Social sharing via Diaspora 1.0.4 ✓ Official
Social sharing via Facebook 1.0.4 ✓ Official
Social sharing via Twitter 1.0.4 ✓ Official
Social sharing via email 1.0.5 ✓ Official

The app will be downloaded from the app store

Take the time to explore all of NextCloud's administrative settings—accessible when choosing "Settings" from your user menu. For example, "Overview" is where to check for updates to both NextCloud and NextCloudPi, while "Basic Settings" houses options to set up access to email notifications by linking into your existing mail SMTP server.

Also make sure you explore the "Apps" section, where you'll find all kinds of add-ons to extend your server's functionality. This is where you go to plug in extras, such as the ability to share files via social media, or add groupware capabilities in the form of calendar, contacts, and mail—select "App bundles" to get a flavor of what's available.

That's not all—if you'd like to do more in the NextCloud web interface, you'll find options for adding built-in viewers and editors, while the "Security "section has an essential Two-Factor TOTP Provider plugin for adding 2FA authentication for greater security. Don't forget to enforce this via "Settings → Administrative → Security."

Another handy feature is "External Storage," the ability to plug in additional storage locations for NextCloud data. Built-in options let you connect to network shares, but check the "Tools" section of the apps store, where you'll find options for integrating Google Drive and OneDrive folders.

("Documents" and "Photos"). The interface is like that found in other cloud backup web interfaces—you can view, download, or delete files from here, plus add new files and share them with others (see the annotation opposite for details).

» NextCloud operates a multi-user system. If you're the sole person using it, the main ncp user is enough, but click the red "N" button in the top-right corner and select "Users" if you need to create additional accounts. Click "New user," give them a suitable username, display name, and password, and enter an optional email address. Don't click "Add user in group" to place them in the admin user group (reserve this for your own account), then click the "Default quota" drop-down to place a limit on how much storage space they can use —the choices are rather inflexible, so to set a more practical default, click the "Settings" button in the bottom-left corner, click inside the "Unlimited" box, type your new limit (for example, 50GB), and click the "+" button [**Image C**].

» Once created, users must log into their own accounts through the web interface at least once. Going forward, they can access their files and restore earlier versions as already outlined above. By clicking their profile letter in the top-right and choosing "Settings," they can also tweak their own personal settings (the administrator settings are obviously off limits to anyone who isn't a member of the admin group), including uploading a profile picture. Direct them to the "Mobile & desktop" section to access links for downloading the client, plus connect other services, such as their contacts and calendar.

6

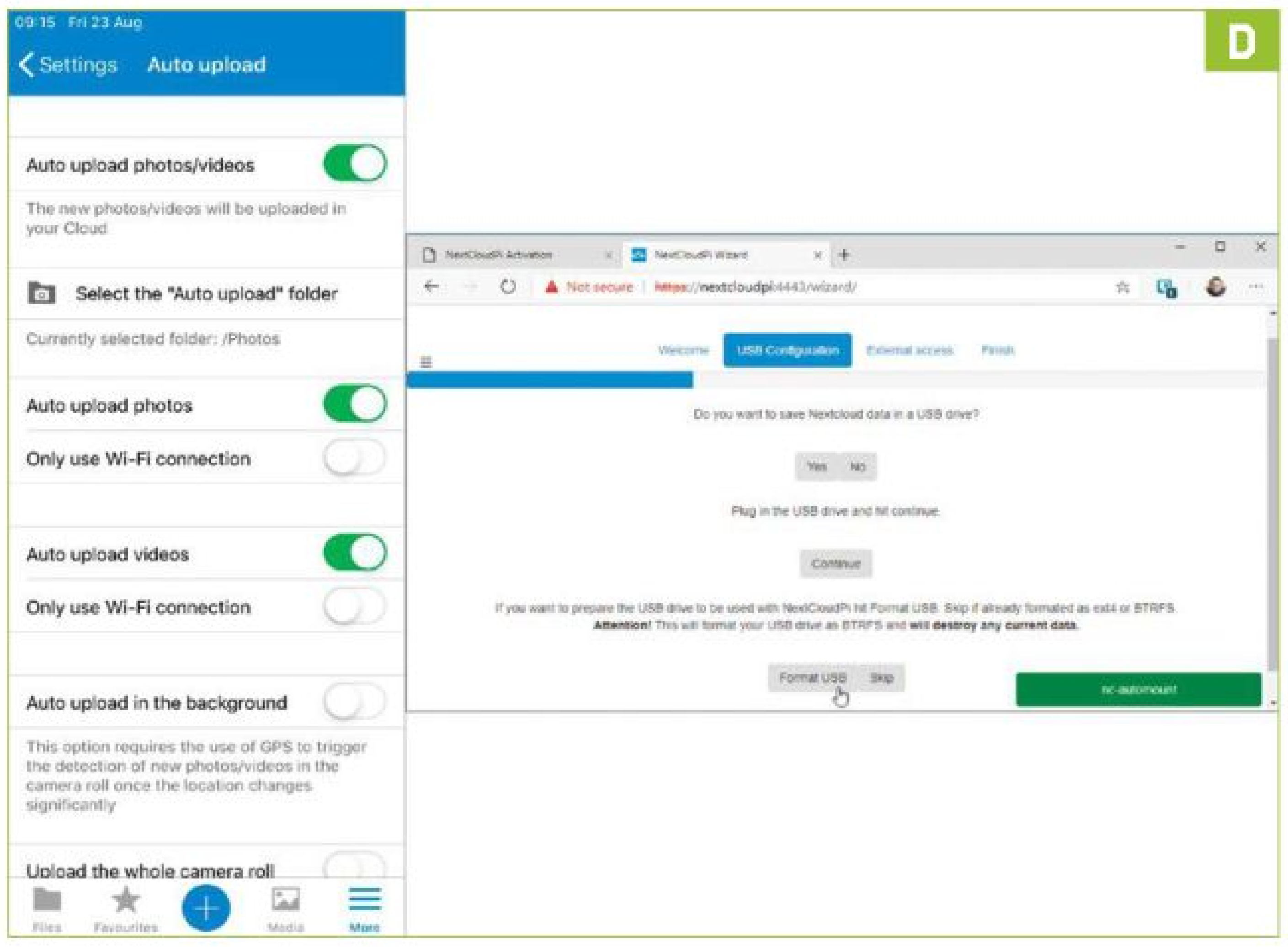
INSTALL DESKTOP CLIENT

Like all good cloud backup and sync services, NextCloud provides free desktop clients for Windows, Mac, and Linux. These do the hard work of keeping your files in sync between all your devices and your centralized folder on the NextCloud server. If you're not logged into NextCloud on the web, head over to https://nextcloud.com/install/#install-clients and download the version you need for Windows, Mac, or Linux (after downloading the Linux AppImage, right-click the file, and choose "Properties → Permissions," then check "Allow executing file as program").

» Install or launch the software, then click "Log in." Type in your server address (typically https://nextcloudpi.local/ or your DDNS domain, if accessing outside the network), then click "Next." You may receive a certificate warning at this point—check "Trust this certificate anyway" and click "OK" followed by "Yes" if prompted. You're now redirected to a sign-in page within the app—click "Log in," enter your username and password, and then click "Grant access" to link your computer to your NextCloud account.

» You can now choose what to sync—"Everything" is the default choice, and will sync everything to a single folder on your hard drive, which is defined using the "Local Folder" button. If you select a folder containing existing data, which is likely if you're looking to back up from your computer for the first time, be sure to leave "Keep local data" selected to avoid losing it all. You'll also see confirmation options for synching large folders (500MB by default, but adjustable) and so-called external storages, which are third-party cloud accounts linked to NextCloud.

» You might prefer to only sync specific folders from the server; perhaps you have data needed for your laptop but not desktop, or you'd like to link NextCloud on a granular level—in other words, set up separate sync folders for different types of content. An obvious example might be linking "Documents" and "Pictures" folders separately, in case they're not all stored inside the same user folder. After creating these folders through the web interface, click "Choose what to sync," and select one of the folders before clicking "OK." Click "Connect..." to make the connection.



Auto upload photos/videos ●
The new photos/videos will be uploaded in your Cloud
Select the "Auto upload" folder
Currently selected folder: /Photos
Auto upload photos ●
Only use Wi-Fi connection ○
Auto upload videos ●
Only use Wi-Fi connection ○
Auto upload in the background ○
This option requires the use of GPS to trigger the detection of new photos/videos in the camera roll once the location changes significantly
Upload the whole camera roll ○

https://nextcloudpi:4443/wizard/

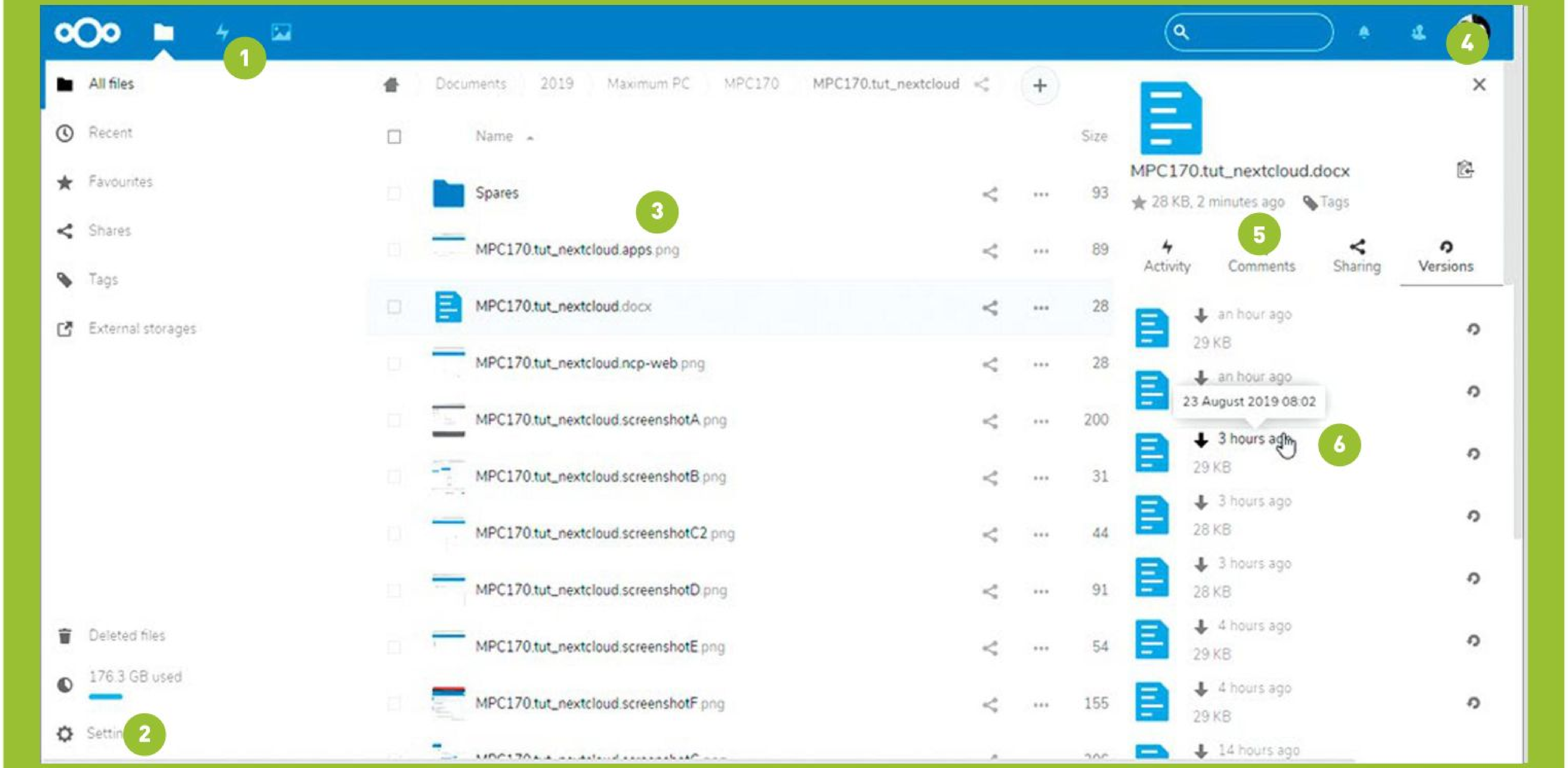
Do you want to save Nextcloud data in a USB drive?

Plug in the USB drive and hit continue.

If you want to prepare the USB drive to be used with NextCloudPi hit Format USB. Skip if already formated as ext4 or BTRFS.
Attention! This will format your USB drive as BTRFS and **will destroy any current data.**

© NEXTCLOUD

THE NEXTCLOUD WEB INTERFACE



Name	Size
Spares	93
MPC170.tut_nextcloud.apps.png	89
MPC170.tut_nextcloud.docx	28
MPC170.tut_nextcloud.ncp-web.png	28
MPC170.tut_nextcloud.screenshotA.png	200
MPC170.tut_nextcloud.screenshotB.png	31
MPC170.tut_nextcloud.screenshotC2.png	44
MPC170.tut_nextcloud.screenshotD.png	91
MPC170.tut_nextcloud.screenshotE.png	54
MPC170.tut_nextcloud.screenshotF.png	155

Version	Size
an hour ago	29 KB
an hour ago	
3 hours ago	29 KB
3 hours ago	28 KB
3 hours ago	28 KB
4 hours ago	29 KB
4 hours ago	29 KB
14 hours ago	

1. SWITCH VIEW
Click here to move between files, activity, gallery, and other configured tools, such as calendar or contacts.

2. SETTINGS
Click here to show or hide hidden files and reveal the address required to access your files via WebDAV.

3. FILE PICKER
The contents of the selected folder are displayed here. Click a file to download it, or right-click for more options. Click the "Sharing" button to reveal the properties panel shown on the right.

4. USER MENU
Click your user avatar here to reveal a drop-down menu giving you access to settings, apps, and help. Administrators can also create new users and manage existing ones from here.

5. SHARING OPTIONS
Click "Share" to reveal these tabs. Use "Comments" to attach comments to files, and "Sharing" to access options for sharing files with others. Plug in more sharing options using "Apps."

6. ROLL BACK THE CHANGES
Select the "Versions" tab to reveal the different iterations of a file that have been saved. Click a version to download a copy to review it—if it's the one you want, click the undo button on the right to make it the current version, and wait for it to sync back to your PC.

7 MONITOR AND MANAGE

The NextCloud activity window opens. You'll see a list of all sync partnerships—click "Add Sync Connection" to create more. You'll also see an indicator of how much storage you've used. Look for the "…" button next to each sync partnership—click it to open the folder, pause an existing sync operation, or "force sync now," which triggers a fresh sync. You can also remove the sync partnership—no data is deleted if you do.

›› The large green check mark indicates a folder is synched—you'll also see icons for paused (gray) and synching (blue). Look out for a yellow icon indicating a potential issue—click the "Activity" button to look for file conflicts, where there's a mismatch between the server version and the one on your computer. The server version is downloaded and the local copy renamed—double-click this to open the folder. Review the files, then delete the version you don't want, renaming the other version to remove the conflicted part of the name.

›› Click the "General" button to tweak settings—including setting the NextCloud client to launch at startup, so your files are always protected. Use the "Network" button to set upload and download bandwidth limits if required. All that's left now is to install the NextCloud on your other computers and follow steps 6 and 7 again to get everything in sync. Finished? Not quite….

8 ACCESS VIA MOBILE

You can also access your files—plus upload photos back to your NextCloud storage—using the free mobile app for Android and iOS. After installing it through the relevant app store, open the app, and follow the prompts (like the desktop client) to link to your NextCloud account.

›› The primary function of the mobile app is for accessing files on the move, but you can do more. For example, open the iOS app, then tap "More → Settings → Auto upload" to automatically upload photos and videos from your cell phone—be sure to flick the "Only use Wi-Fi connection" switch if you have mobile data [**Image D**].

›› You can also upload manually by adding NextCloud as an option when tapping the upload button in an app such as Photos—when switched on, you can save photos and videos to specific locations. NextCloud also appears as an option in the Document Picker used by supported apps in iOS—tap "Locations" to select it. Once enabled here, you can also make NextCloud the default location for document storage on your iPhone for specific apps by navigating to "Settings → Appname → Document Storage" to choose it over iCloud. ⏻

Create an OLED Raspberry Pi Monitor

YOU'LL NEED THIS

ANY RASPBERRY PI

Plus an I2C OLED screen (128x 64 pixels), and four female-to-female jumper wires.

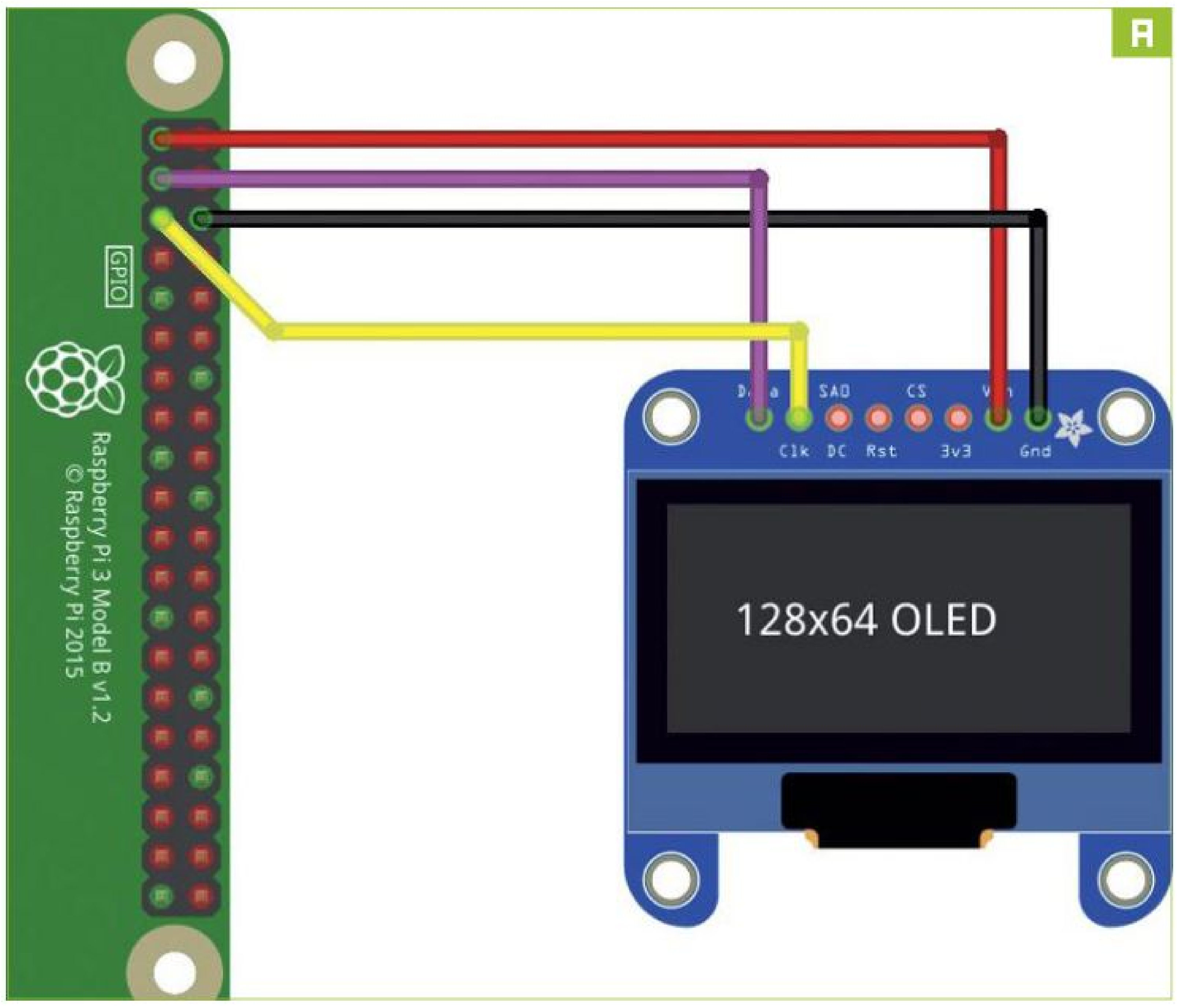
THE CODE

Download it from http://bit.ly/lxf254i2c.

THIS HANDY PROJECT results in a tiny OLED screen that provides useful data about a Raspberry Pi at a glance. We can also run our project on boot to monitor the system as we work.

The OLED screen connects to the Raspberry Pi GPIO using an I2C interface. This is a special interface that only needs four pins on the Pi in order to send data. To connect your Pi, please refer to the diagram below [**Image A**].

With the physical connection made, we need to enable I2C on our Pi—do this in the Raspberry Pi Configuration tool. We also need to install two Python libraries for this project, so in a terminal, enter the following command: `$ sudo pip3 install Adafruit-SSD1306 netifaces`. The first library is for our OLED screen, while the second enables our code to work with network interfaces. **–LES POUNDER**



1 WRITING THE CODE

To write the code, we shall be using Thonny, the default Python editor on the latest Raspbian. You're free to use any editor you want, but please save the code as "live-data.py"—and save often. We start the code with a line indicating where our Python 3 interpreter is located. Our project will be a background app in the system, so this enables it to run.

```
#! /usr/bin/env python3
```

›› We now import three libraries to add features to our code. The first enables us to use the OLED screen with Python. The second is used for accessing system information in Python. The last is used to access network interface information. Note that we import netifaces, but refer to it as "ni" for ease of use.

```
import Adafruit_SSD1306
import psutil
import netifaces as ni
```

›› Three more imports, all from the Python Imaging Library (PIL). These will handle drawing content on the screen.

```
from PIL import Image, ImageDraw, ImageFont
```

›› In order to use the OLED screen [**Image B**], we need to tell Python where it is, and what size it is. For this we create an object called `disp` and in there we use the Adafruit library, specifically the `128_64` function. Note that the screen does not have a reset pin (`rst`) so we set that to `None`. Then we begin the connection to the screen.

```
disp = Adafruit_SSD1306.SSD1306_128_64(rst=None)
disp.begin()
```

›› To configure the screen, we need to know the width and height; luckily, the function handles that. These are saved to variables, and then the screen is set to 1-bit color (black and white).

```
width = disp.width
height = disp.height
image = Image.new('1', (width, height))
```

›› Preparing the screen for output, we create an object to which we can draw.

```
draw = ImageDraw.Draw(image)
```

›› Now we set the confines of the screen. The `padding` variable enables us to stay inside the screen; we set the top to match the padding, and the bottom of the screen as the height minus the padding. We also create a variable, `x`, to keep track of where text will appear on the horizontal axis.

```
padding = -2
top = padding
bottom = height-padding
x = 0
```

2 DATA DETAILS

Now we need to gather the data for our screen. The first data collected is the CPU's temperature, and for this we open a file in read-only mode. This file stores the data from the CPU temp sensor, which we save to a variable called `f`.

```
f = open("/sys/class/thermal/thermal_zone0/temp", "r")
t = f.readline()
```

›› Because the data is stored as a string, in order to do any math with it, we need to convert it to a `float`. The value stored is far too large, so we divide it by 1,000, and round the returned value to one decimal place, giving us the correct temperature.

```
t = float(t)
t = round(t/1000,1)
```

›› To get the CPU usage percentage, we create a variable called `cpu` and store the output from the `psutil.cpu_percent()` function in it. We round the value down, with no decimal place, for ease of reference.

```
cpu = psutil.cpu_percent(interval=1)
cpu = round(cpu)
```

›› To get the RAM usage, we again use `psutil`, specifically the virtual memory function. This returns a list of data, and from the list we need the second value, which is available memory. To get the second item, we use `[1]`, because a list starts from 0. Then we do a little math on the value in memory, which represents bytes. We need to convert it to megabytes, so we divide the value by 1,024, twice.

```
memory = psutil.virtual_memory()
memory = memory[1]
memory = round(memory / 1024 / 1024)
```

3 ADDRESSES AND ALERTS

The final piece of data is the internal IP address of the Ethernet port. For this we create a variable called `ip` and store the data obtained from the netifaces `ifaddresses` function in it. This requires the interface name as an argument, and in the returned data we need to go into a series of nested lists: first at position 2, then inside that list, position 0. Then we use the `addr` key to retrieve the data stored in a dictionary.

```
ip = ni.ifaddresses('eth0')[2][0]['addr']
```

›› The next step is to add an alert for our CPU. If the temp (`t`) is over 50 C, it will change the text on the screen. Otherwise, we get `NOMINAL`.

```
if t > 50:
    ALERT = "CPU TEMP ALERT"
else:
    ALERT = "NOMINAL"
```

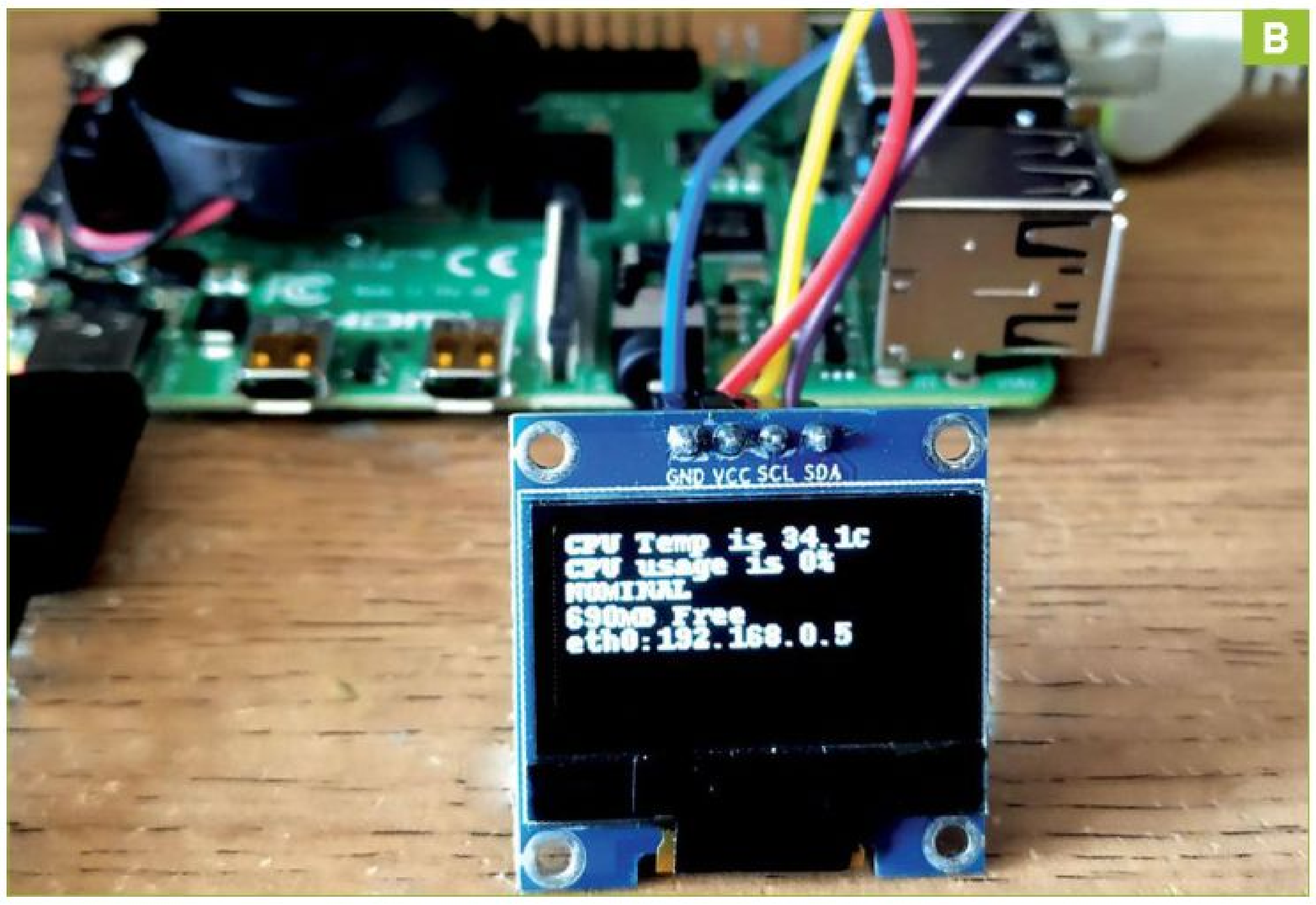
4 TEXT TALK

We now start writing text to the screen. The first two lines write the CPU temp and usage. The first line is our CPU temp, and you'll see that we start writing in the top-left (`x`), two pixels from the top of the screen (top is -2). We write a string of text, and convert it to a string `t`. Then we use the default font, and set the color to `255` (white). The second line is the same, but we set the move down eight pixels.

```
draw.text((x, top),       "CPU Temp is "+str(t)+"C",
font=ImageFont.load_default(), fill=255)
draw.text((x, top+8),   "CPU usage is "+str(cpu)+"%",
font=ImageFont.load_default(), fill=255)
```

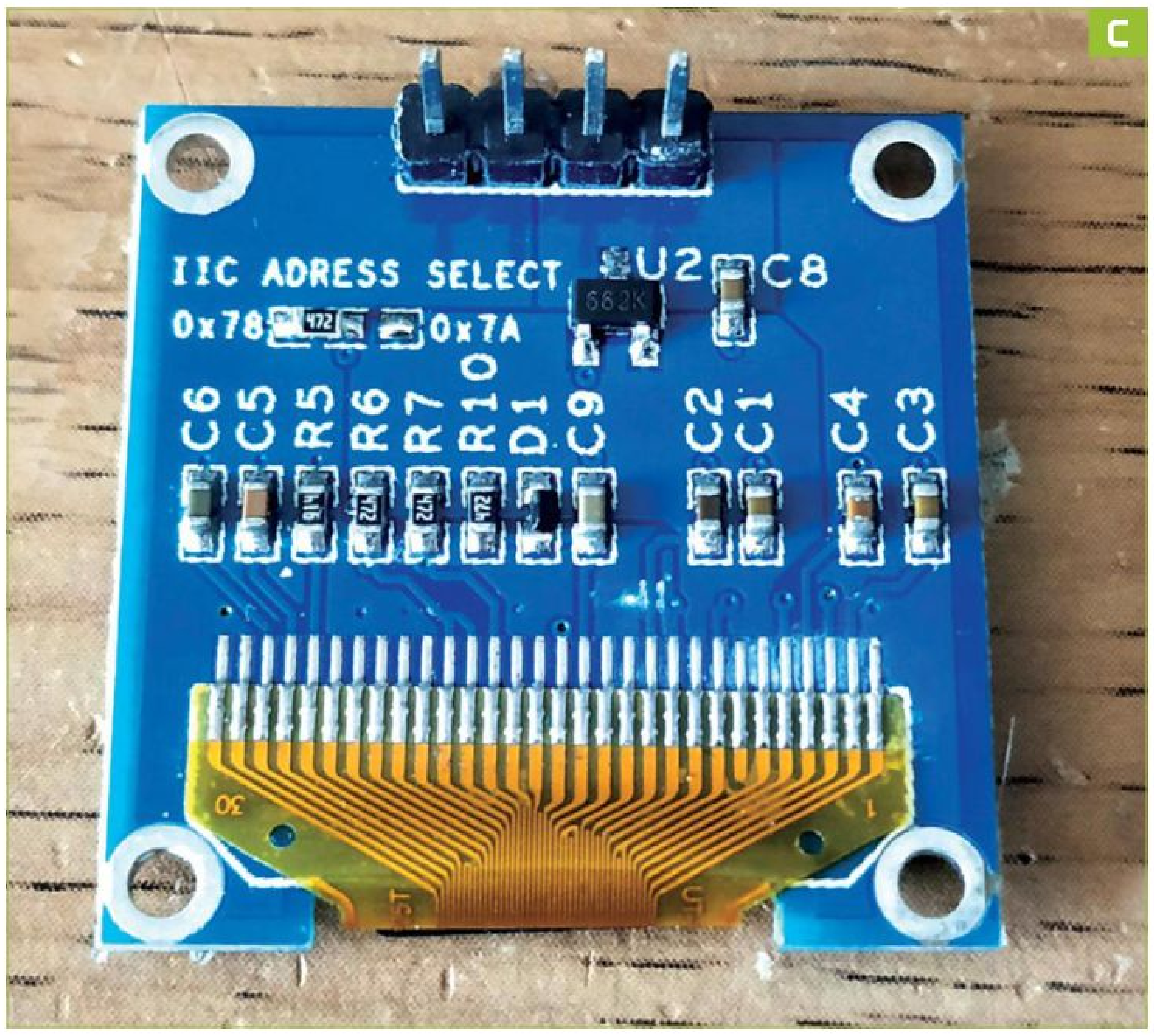
›› The next three lines are our Alert status, available RAM, and IP address.

```
draw.text((x, top+16),     ALERT, font=ImageFont.load_default(),
fill=255)
draw.text((x, top+25),    str(memory)+"MB Free",
font=ImageFont.load_default(), fill=255)
```



```
CPU Temp is 34.1C
CPU usage is 0%
NOMINAL
690MB Free
eth0:192.168.0.5
```

© RASPBERRY PI FOUNDATION



```
draw.text((x, top+33),     "eth0:"+ip,  font=ImageFont.
load_default(), fill=255)
```

›› The very final two lines of this code update the display and show the live data.

```
disp.image(image)
disp.display()
```

›› Save the code and click "Run"; your OLED screen comes to life and displays the latest data for your machine. See the box below to have this code run on boot. If you find you need to change the I2C address for your screen, desolder the connection to 0x78, and make a new one to 0x7A [**Image C**].

RUNNING THE CODE ON BOOT

Our project is best used on boot, so here are the extra steps to make that happen. First, we need to make our code executable, and for that we must open a terminal and type:

```
$ chmod +x live-data.py
```

Now, to make the code available to everyone as a command, we need to copy it to "/usr/bin," so in the terminal type:

```
$ sudo cp live-data.py /usr/bin/live-data
```

Give the command a try. In the terminal, type the following, and watch the OLED screen.

```
$ live-data
```

So, now we have the command, let's use it on boot. In the terminal, we shall use crontab and edit cron to start the command on boot and run the command every minute that the Pi is on.

```
$ sudo crontab -e
```

In crontab, go to the bottom and add this line.

```
* * * * * live-data >/dev/null 2>&1
```

Now save by pressing Ctrl-X and pressing Y, then Return. That's it! Now you can reboot your Pi and watch your OLED screen, because every minute your Pi is on, it gives you live data. The lengthening fall evenings will just fly by....

Free Up Valuable Space on Your SSD

YOU'LL NEED THIS

WINDIRSTAT
Download this analytical tool from https://windirstat.net.

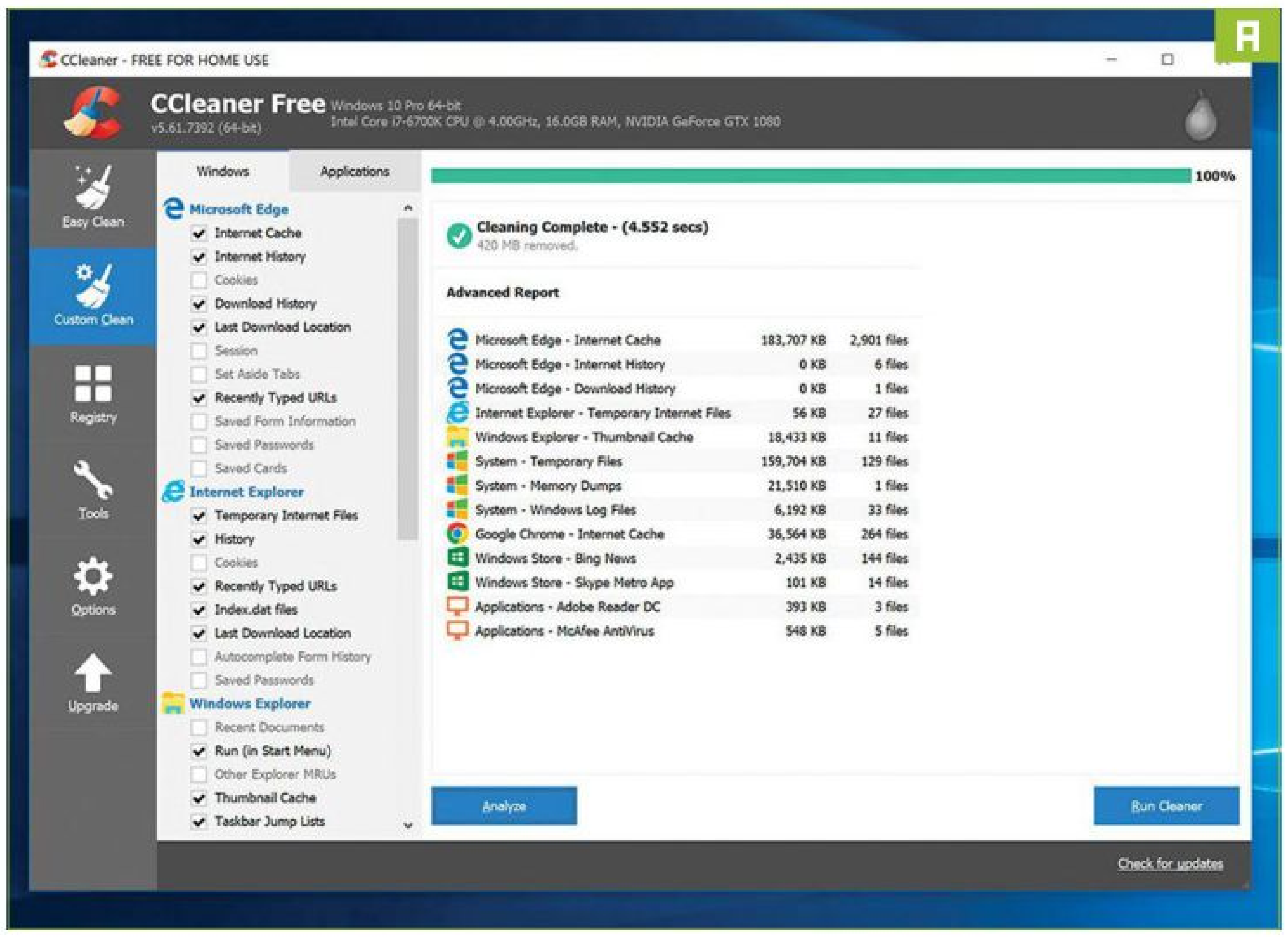
CCLEANER
You can grab it from www.ccleaner.com.

ALTHOUGH SSD PRICES KEEP FALLING every year, they're still significantly more expensive than an HDD of equivalent capacity. That means your SSD is likely to fill up much more quickly than a similarly priced HDD, leaving you scrambling for ways to free up much-needed space.

Fortunately, there are several things you can do to reclaim storage space on your SSD. From moving system folders to disabling hibernation, it can be both quick and straightforward to get back precious SSD space.

However, before we dive in to the steps you should take, the first thing to do is work out where the culprits lie. We recommend downloading the free tool WinDirStat. It scans a selected drive on your computer and reveals which files and folders are taking up the most space, illustrated by blocks of varying colors and sizes. Armed with that knowledge, you can delete large unused files and uninstall unnecessary programs to help free up space.

Some of the steps in this guide used to be recommended as ways to improve your SSD's performance; these days, they're unnecessary for that purpose, but can still be a great way to regain space on a crowded SSD. So, let's clear the cruft and do a spot of cleaning. **–ALEX BLAKE**


A
CCleaner - FREE FOR HOME USE
CCleaner Free
Easy Clean
Custom Clean
Registry
Tools
Options
Upgrade
Windows
Applications
100%
Analyze
Run Cleaner
Check for updates

CCleaner Free Windows 10 Pro 64-bit
v5.61.7392 (64-bit) Intel Core i7-6700K CPU @ 4.00GHz, 16.0GB RAM, NVIDIA GeForce GTX 1080

Microsoft Edge
- ☑ Internet Cache
- ☑ Internet History
- ☐ Cookies
- ☑ Download History
- ☑ Last Download Location
- ☐ Session
- ☐ Set Aside Tabs
- ☑ Recently Typed URLs
- ☐ Saved Form Information
- ☐ Saved Passwords
- ☐ Saved Cards

Internet Explorer
- ☑ Temporary Internet Files
- ☑ History
- ☐ Cookies
- ☑ Recently Typed URLs
- ☑ Index.dat files
- ☑ Last Download Location
- ☐ Autocomplete Form History
- ☐ Saved Passwords

Windows Explorer
- ☐ Recent Documents
- ☑ Run (in Start Menu)
- ☐ Other Explorer MRUs
- ☑ Thumbnail Cache
- ☑ Taskbar Jump Lists

Cleaning Complete - (4.552 secs)
420 MB removed.

Advanced Report

Microsoft Edge - Internet Cache	183,707 KB	2,901 files
Microsoft Edge - Internet History	0 KB	6 files
Microsoft Edge - Download History	0 KB	1 files
Internet Explorer - Temporary Internet Files	56 KB	27 files
Windows Explorer - Thumbnail Cache	18,433 KB	11 files
System - Temporary Files	159,704 KB	129 files
System - Memory Dumps	21,510 KB	1 files
System - Windows Log Files	6,192 KB	33 files
Google Chrome - Internet Cache	36,564 KB	264 files
Windows Store - Bing News	2,435 KB	144 files
Windows Store - Skype Metro App	101 KB	14 files
Applications - Adobe Reader DC	393 KB	3 files
Applications - McAfee AntiVirus	548 KB	5 files

1 USE CCLEANER

CCleaner is a free program that can work wonders when it comes to clearing out space on your SSD. Just install it and set it to work, and you'll have freed up a ton of space in no time.

›› CCleaner has several sections that are worth exploring. The first is "Easy Clean." This analyzes your computer to detect what can be quickly cleaned up, including web browser trackers and cookies, and unnecessary junk, such as temporary system files and the contents of the Recycle Bin.

›› If you want a bit more control on what's cleaned up from your SSD, use the "Custom Clean" section. Here, you can choose what system and program files are cleaned out, from memory dumps and the contents of the clipboard to caches on a per-browser basis, and more.

›› As you can see [**Image A**], CCleaner cleaned out 420MB after a scan that lasted less than five seconds. If you've never run it before, you'll likely be able to clear out gigabytes instead of megabytes.

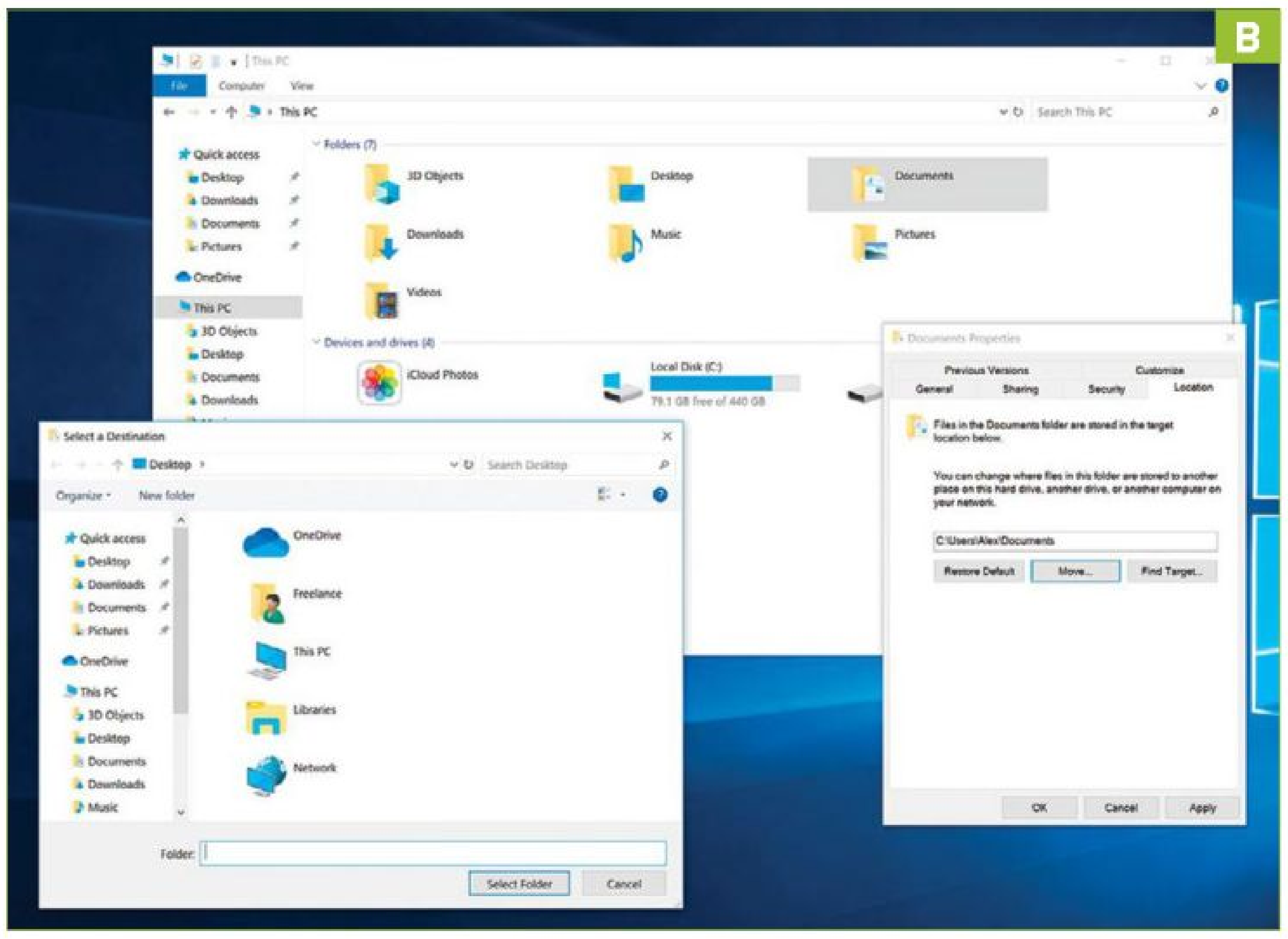
2 USE DISK CLEANUP

If you don't want to install CCleaner and would prefer to stick to Windows 10's own tools, you can use Disk Cleanup. It's not as wide-ranging as CCleaner, but can clear a few problem cases with just a couple of clicks.

›› To get started, type "Disk Cleanup" into the Windows 10 search bar and click the top result. Select your SSD from the list of drives, then click "OK." You'll now see a list of suggestions for what you can clean out, including things such as temporary Internet files, thumbnails, the DirectX shader cache, and more, each with an estimated file size next to it and a description below. Check the box next to anything you would like to clear, then press "OK."

›› Disk Cleanup also enables you to remove unnecessary system files. Click "Clean up system files," then select your SSD as before, and press "OK." You'll see many of the same items as before, alongside some new options, such as "Windows Update Cleanup" and "Windows upgrade log files." These can potentially clean up several gigabytes' worth of space.

›› You can also clear all but the most recent system restore point if you feel older ones are no longer needed. After clicking "Clean up system files" and selecting your SSD, click the "More Options" tab at the top of the


B
This PC
File
Computer
View
Search This PC
Quick access
Desktop
Downloads
Documents
Pictures
OneDrive
This PC
3D Objects
Folders (7)
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
Devices and drives (4)
iCloud Photos
Local Disk (C:)
79.1 GB free of 440 GB
Documents Properties
Previous Versions
Customize
General
Sharing
Security
Location
Restore Default
Move...
Find Target...
OK
Cancel
Apply
Select a Destination
Desktop
Search Desktop
Organize
New folder
Freelance
Libraries
Network
Music
Folder:
Select Folder
Cancel

Files in the Documents folder are stored in the target location below.

You can change where files in this folder are stored to another place on this hard drive, another drive, or another computer on your network.

C:\Users\Alex\Documents

© WINDIRSTAT, CCLEANER

SHOULD YOU DISABLE SYSTEM RESTORE?

System restore can take up a fair amount of room, and you may see some places recommending you disable it in order to claw back drive space. However, we don't recommend doing so, as system restore can be vital if your PC runs into a problem and needs to be rolled back to an earlier state.

If you're concerned about how much space system restore is consuming, follow our advice in step 2 and use Disk Cleanup to remove old restore points—just make sure you don't need them before you delete them. That way, you can clear out unnecessary restore points that are just taking up space, while not putting your PC at risk.

As always, it's also a good idea to regularly back up your data, giving you another way to restore things if things go south for your PC.

window. In the "System Restore and Shadow Copies" section, click "Clean up," then "Delete."

3

MOVE SYSTEM FOLDERS

By default, all your user account folders are stored on the C drive, which in most computers these days is likely to be an SSD. That means your documents, pictures, videos, and more will be taking up precious space. If you have an HDD, it's a good idea to move them there.

›› The process is very simple. Open Windows Explorer, click "This PC," right-click "Documents," then click "Properties." In the "Properties" window, click the "Location" tab, then click "Move," and browse to where you want to relocate your files [**Image B**] (create a new "Documents" folder if necessary).

›› Once you've browsed to the new location, click "Select Folder." Click "Apply," then click "Yes" when you're asked if you want to move all the contents of the folder.

›› Repeat this process with all the other folders listed under "This PC," including "3D Objects," "Desktop," "Downloads," "Music," "Pictures," and "Videos."

4

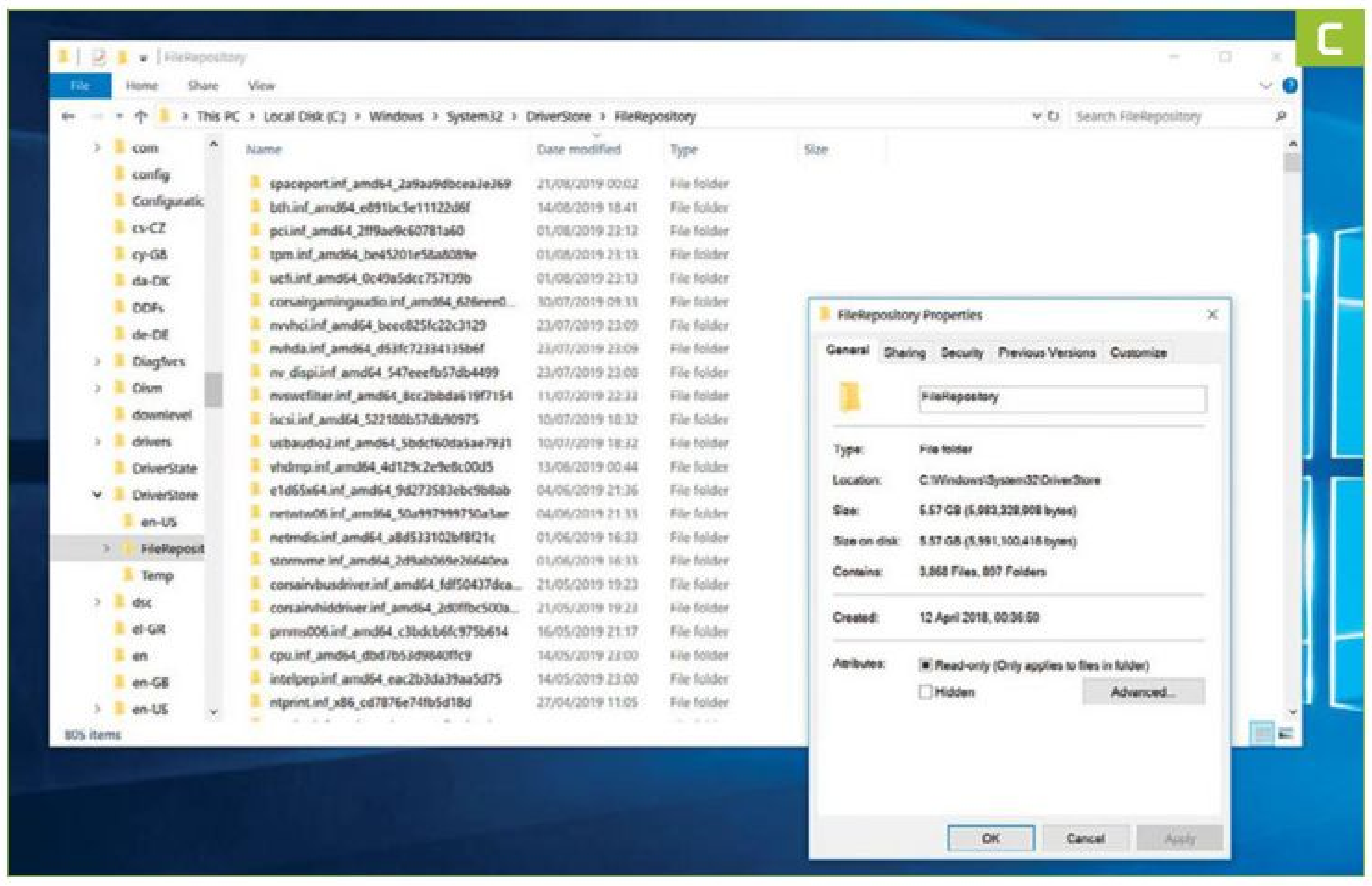
DELETE OLD GPU DRIVERS

Every time you update your graphics card drivers, the old ones are retained in case you need to roll back. Over time, that can take up a tremendous amount of space. Worse, these are stored on your system drive, which in most cases is your SSD.

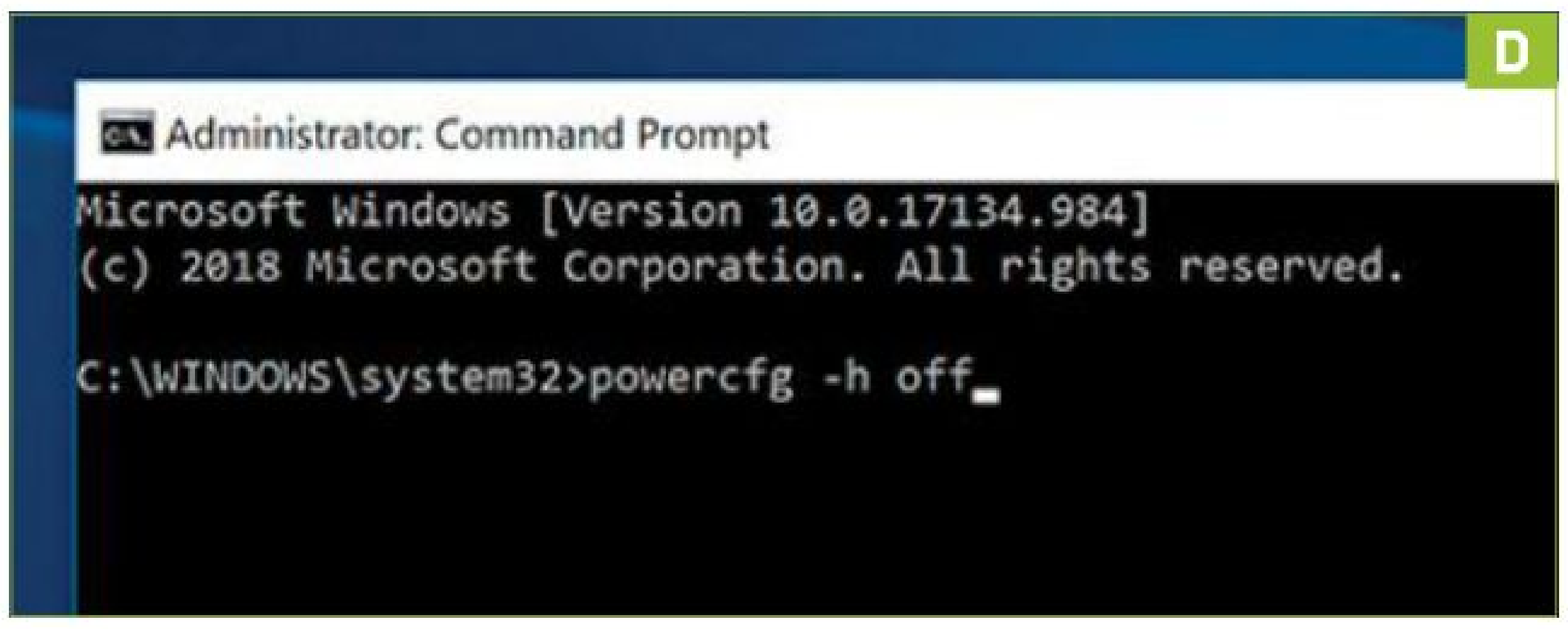
›› The process of removing them depends on whether you're using an Nvidia or AMD GPU. We'll start with Nvidia. Open Windows Explorer and go to C:\ProgramData\NVIDIA Corporation\Downloader. There will be a series of folders with random strings of numbers and letters; these can be deleted. Don't touch any other folders here, though, including the "Config" and "Latest" folders.

›› If you have an AMD video card, go to C:\AMD in Windows Explorer and sort the contents by "Date modified," with newest files at the top. Delete all but the two or three most recent folders, just in case you need to roll your driver back.

›› Regardless of your video card brand, Windows has its own folder where old drivers are stored. Open Windows Explorer and head to C:\Windows\System32\DriverStore\FileRepository; it should look something like the image below-left [**Image C**]. You can delete the contents of this folder. As before, you may want to keep the most recent folders just in case.



Type: File folder
Location: C:\Windows\System32\DriverStore
Size: 5.57 GB (5,983,328,908 bytes)
Size on disk: 5.57 GB (5,991,100,418 bytes)
Contains: 3,868 Files, 807 Folders
Created: 12 April 2018, 00:36:50
Attributes: ■ Read-only (Only applies to files in folder)
☐ Hidden



```
Microsoft Windows [Version 10.0.17134.984]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\WINDOWS\system32>powercfg -h off_
```

5

DISABLE HIBERNATION

Hibernation is designed to let your computer boot up more quickly than it otherwise would. It was initially made for systems using an HDD as a boot drive; these days, the speed of SSDs makes hibernation somewhat unnecessary. Still, if it's enabled on your PC, it'll be taking up a sizeable amount of space. That's because the Windows hibernation file is roughly the same size as the amount of memory your system has—so we're potentially talking 16GB or more.

›› To disable it, type "cmd" into the Windows 10 search box, then right-click the top result and click "Run as administrator." When the command-prompt window loads, type "powercfg -h off" without the quotes [**Image D**], then press Enter.

6

MOVE THE PAGE FILE

In Windows 10, the page file is used to store data when you run out of physical memory; like hibernation, it's usually roughly the same size as your system memory. Some programs rely on the page file existing, and if you disable it you may find your programs start crashing when they aren't able to transfer their data from memory to the page file. For those reasons, you shouldn't outright disable it.

›› However, you can move it to a larger drive in order to free up a big chunk of space on your SSD. To do so, type "Advanced system settings" into the Windows 10 search box, and click the top result. In the "Performance" section at the top of the window, click "Settings." In the resulting box, click the "Advanced" tab, then in the "Virtual memory" section, click "Change."

›› The Virtual Memory settings box appears. Uncheck "Automatically manage paging file for all drives." Click the C drive (it should say "System managed" next to it), click "No paging file," then click "Set." Now, click the drive you wish to move the page file to, click "System managed size," then click "Set," then "OK." ⏻

Stay Secure in Windows 10

YOU'LL NEED THIS

WINDOWS 10
You might also want to install Bitdefender from http://bitdefender.com.

THE INTERNET IS FULL OF WONDERFUL THINGS, but it's also full of malicious software. Connecting any PC to the internet without setting up any security features is a little like leaving your car unlocked in the bad part of town, with a giant neon sign flashing "Steal Me!" The good news is that it's really straightforward to keep your PC, and your data, safe.

Malicious software tends to do one of three things. It might do damage, such as destroy data. It might force you to look at pages or ads you didn't ask for. Or it might try to access your personal data. Fortunately, as we'll discover, Windows 10 is packed with features that can fight all three kinds of malicious software. You don't necessarily have to use Windows' own features, though—if you prefer, you can use a different browser, such as Firefox, or third-party anti-malware software. **–CARRIE MARSHALL**

1 SECURITY NOTIFICATIONS

If Windows identifies a potential security problem on your PC, it flags it up in the notification area of the Start Bar—but you might need to use the expand arrow to see it if there are multiple apps using that section. Clicking the notification opens Windows Security, where you can see how to deal with the issue. In our example [**Image A**], Windows is prompting us to improve our account protection.

2 SET UP THE FIREWALL

Windows includes its own firewall, which is a security app designed to stop malicious apps from sending things to or from your PC. You'll find it in "Control Panel → System and Security → Windows Defender Firewall" [**Image B**]. You don't have to use Microsoft's version, but it's a very good idea to use a firewall if you're connecting to shared or public networks, such as public Wi-Fi hotspots.

3 ADJUST EDGE'S SCREENING

Windows also provides SmartScreen, which analyzes apps, files, and even websites for potentially dangerous content. You can adjust its settings in "Windows Security → App & Browser Control." For example, instead of setting SmartScreen to "warn," which is the default action, you can make it block anything it isn't 100 percent sure of [**Image C**]. That's handy if you share your PC with inquisitive children.

4 TWEAK EDGE'S SETTINGS

In the Edge browser, bringing up "Settings → Privacy & Security" enables you to adjust more things to keep you safe online. Scroll down and make sure both "Block Pop-Ups" and "Windows Defender SmartScreen" are enabled [**Image D**]. The former does a pretty good job of blocking those official-looking pop-up windows that villains use to trick you into visiting their fake and/or fraudulent websites.

5 TURN OFF FLASH

Don't quit Edge just yet. In "Settings," click "Advanced" and look for "Use Adobe Flash Player" [**Image E**]. Turning that off is a very good idea—Flash used to be necessary to play online videos, but over the years, it's become notorious for security problems. While you're here, you can also disable autoplaying videos and music, which aren't necessarily security problems, but are just annoying.

6 INSTALL AN AD-BLOCKER

One of the most common security issues on the Internet is the way advertising networks often behave badly; they track you whether you want them to or not, they get in your way when you're trying to read things, and they can often make browsing the Internet a terrible experience. You can block trackers and many unpleasant ads with an ad-blocking extension for Edge.

7 WHITELIST THE GOOD GUYS

Most ad-blockers enable you to disable blocking for specific sites. That's important for sites that are above board; many depend on advertising revenue to pay their bills, so if everybody blocks the ads, they'll go out of business. If a site you want to support runs particularly annoying ads, most blockers enable you to block the specific ad rather than the entire site.

8 USE DIFFERENT SOFTWARE

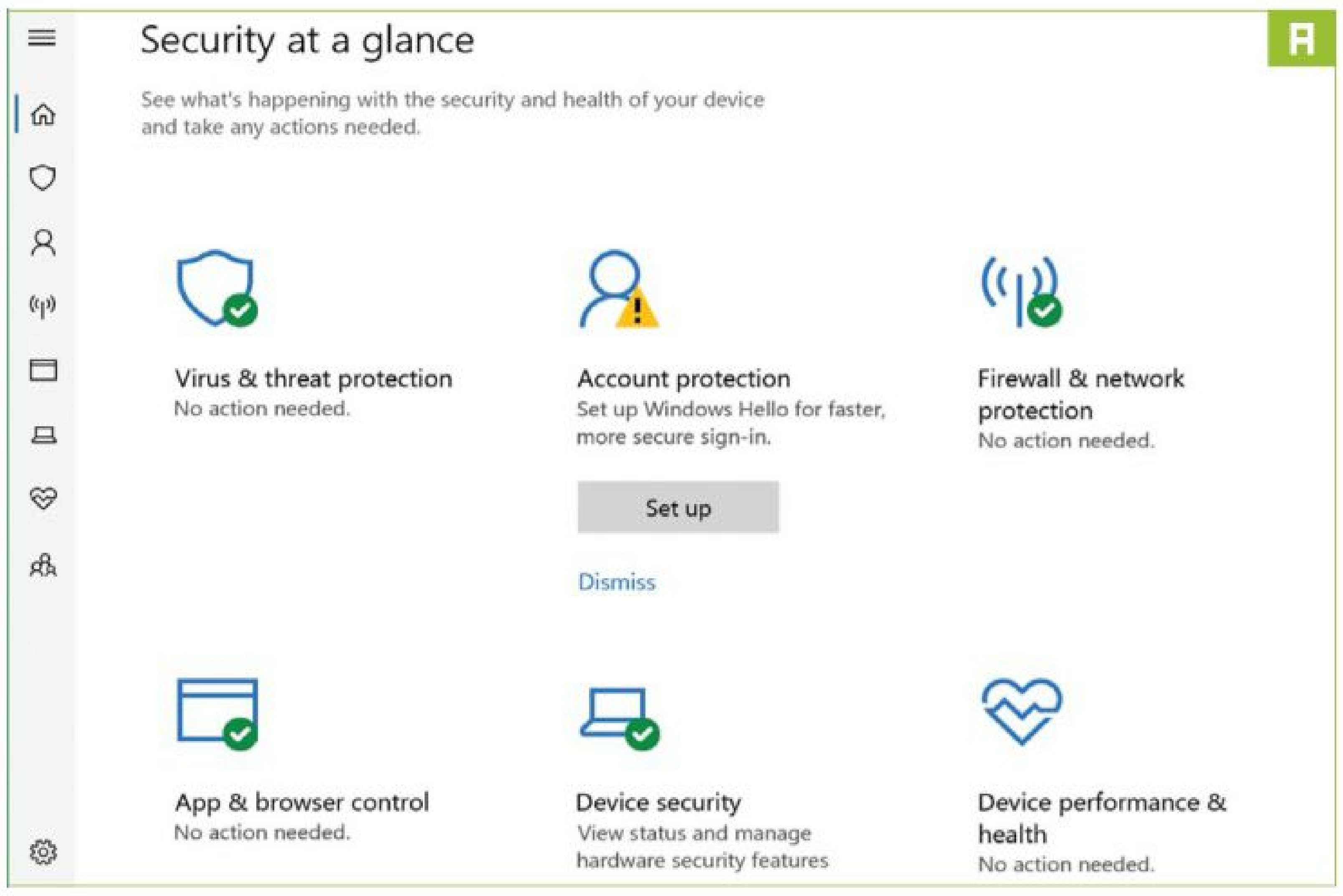
You don't have to stick with Windows' security software, and in the case of antivirus protection, it's a good idea to go for a reputable alternative, such as Bitdefender [**Image F**]. Whatever you use, run security scans regularly in case something bad has snuck in.

9 DON'T PANIC

If you think malicious software has infected your PC, don't panic. If you don't already have anti-malware software, download the Microsoft Windows Malicious Software Removal Tool [**Image G**]. This can detect lots of known baddies and safely remove them from your system, but it's important to note that it's just a cleanup tool—you should still have security software installed on your PC.

10 KEEP EVERYTHING UPDATED

One of the simplest ways to keep your system secure is to ensure Windows and your apps are up to date [**Image H**]. That's because of security exploits, which are like little security holes in apps or in Windows—once they've been found, malicious software can use them to get into your computer. If you install updates that close the security holes, there's nothing for the villains to exploit. ⏻


A

Security at a glance

See what's happening with the security and health of your device and take any actions needed.

Virus & threat protection
No action needed.

Account protection
Set up Windows Hello for faster, more secure sign-in.

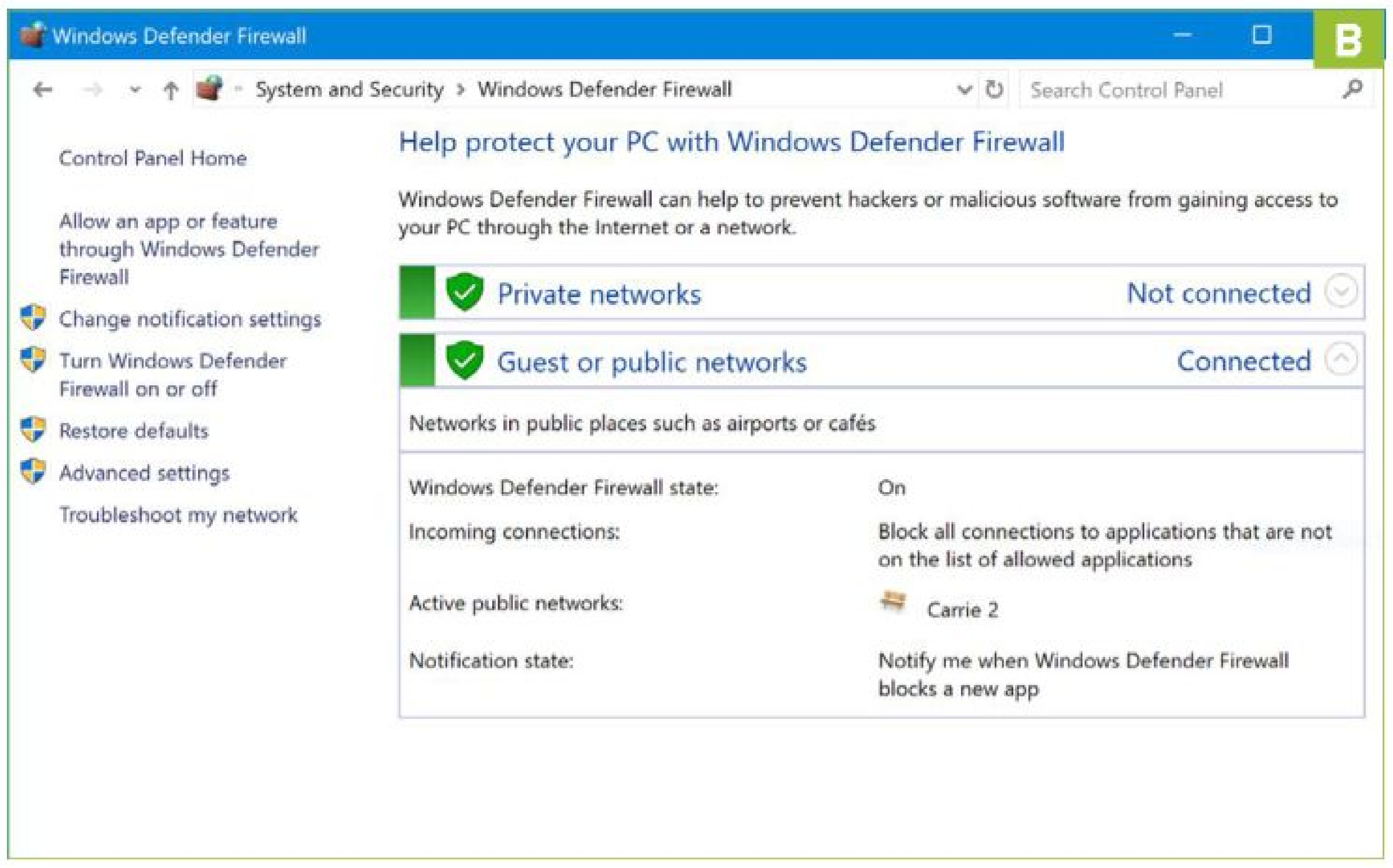
Set up
Dismiss

Firewall & network protection
No action needed.

App & browser control
No action needed.

Device security
View status and manage hardware security features

Device performance & health
No action needed.


B
Windows Defender Firewall
System and Security › Windows Defender Firewall
Search Control Panel
Control Panel Home
Allow an app or feature through Windows Defender Firewall
Change notification settings
Turn Windows Defender Firewall on or off
Restore defaults
Advanced settings
Troubleshoot my network

Help protect your PC with Windows Defender Firewall

Windows Defender Firewall can help to prevent hackers or malicious software from gaining access to your PC through the Internet or a network.

Private networks — Not connected

Guest or public networks — Connected

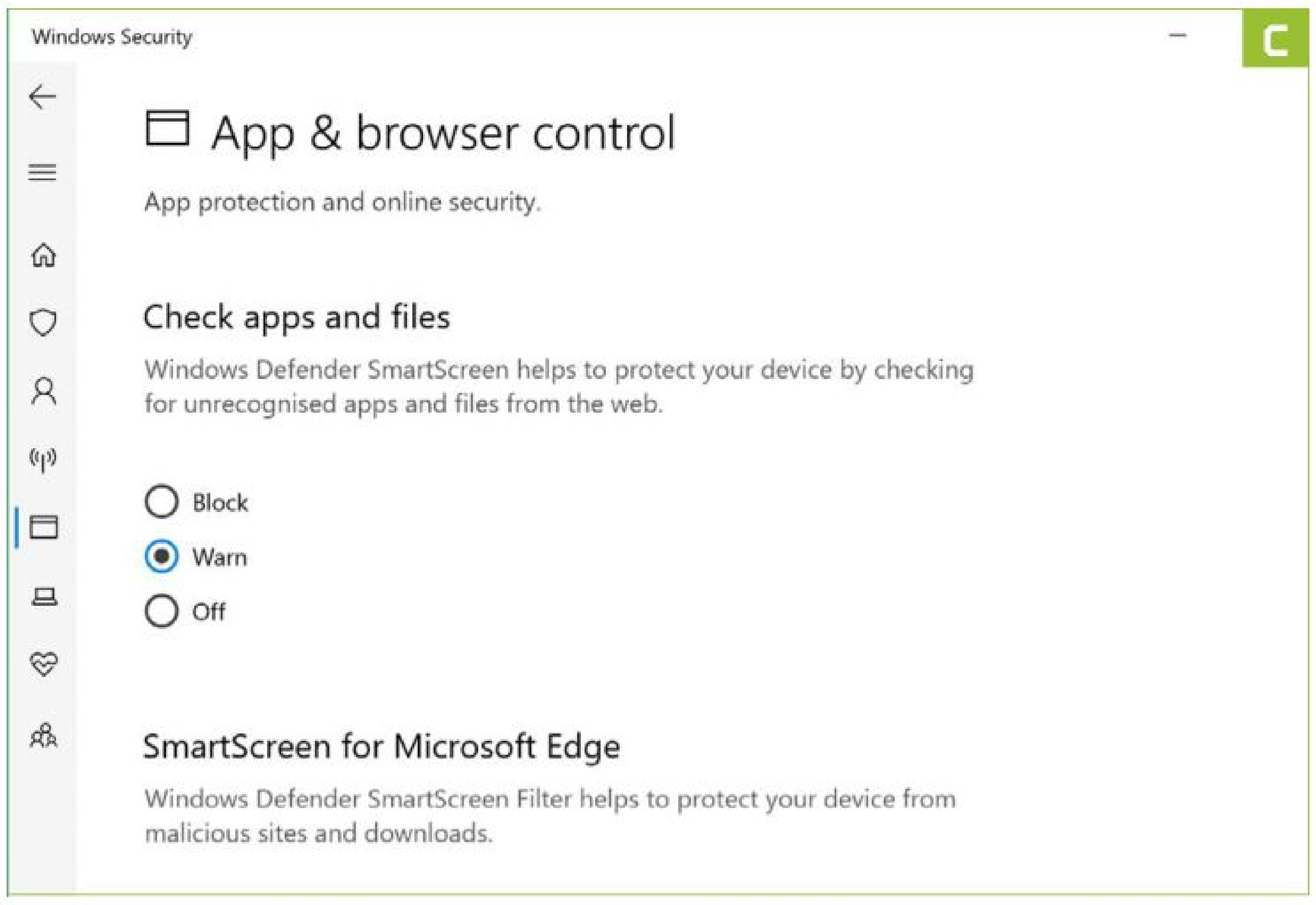
Networks in public places such as airports or cafés

Windows Defender Firewall state: On

Incoming connections: Block all connections to applications that are not on the list of allowed applications

Active public networks: Carrie 2

Notification state: Notify me when Windows Defender Firewall blocks a new app


C
Windows Security

App & browser control

App protection and online security.

Check apps and files

Windows Defender SmartScreen helps to protect your device by checking for unrecognised apps and files from the web.

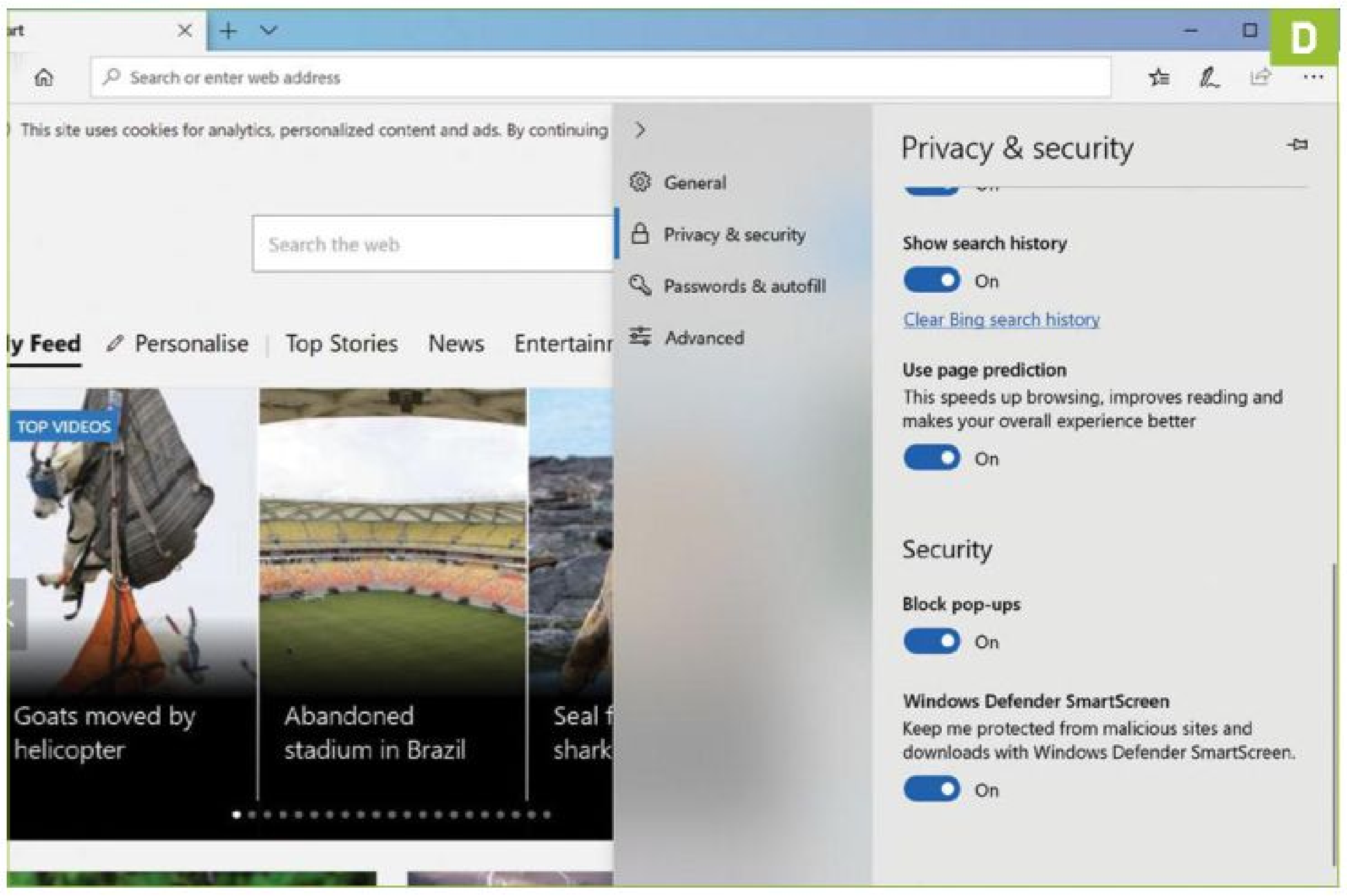
○ Block

● Warn

○ Off

SmartScreen for Microsoft Edge

Windows Defender SmartScreen Filter helps to protect your device from malicious sites and downloads.


D
Search or enter web address
This site uses cookies for analytics, personalized content and ads. By continuing
Search the web
y Feed
Personalise
Top Stories
News
Entertainr
TOP VIDEOS
Goats moved by helicopter
Abandoned stadium in Brazil
Seal f shark
General
Privacy & security
Passwords & autofill
Advanced

Privacy & security

Show search history: On

Clear Bing search history

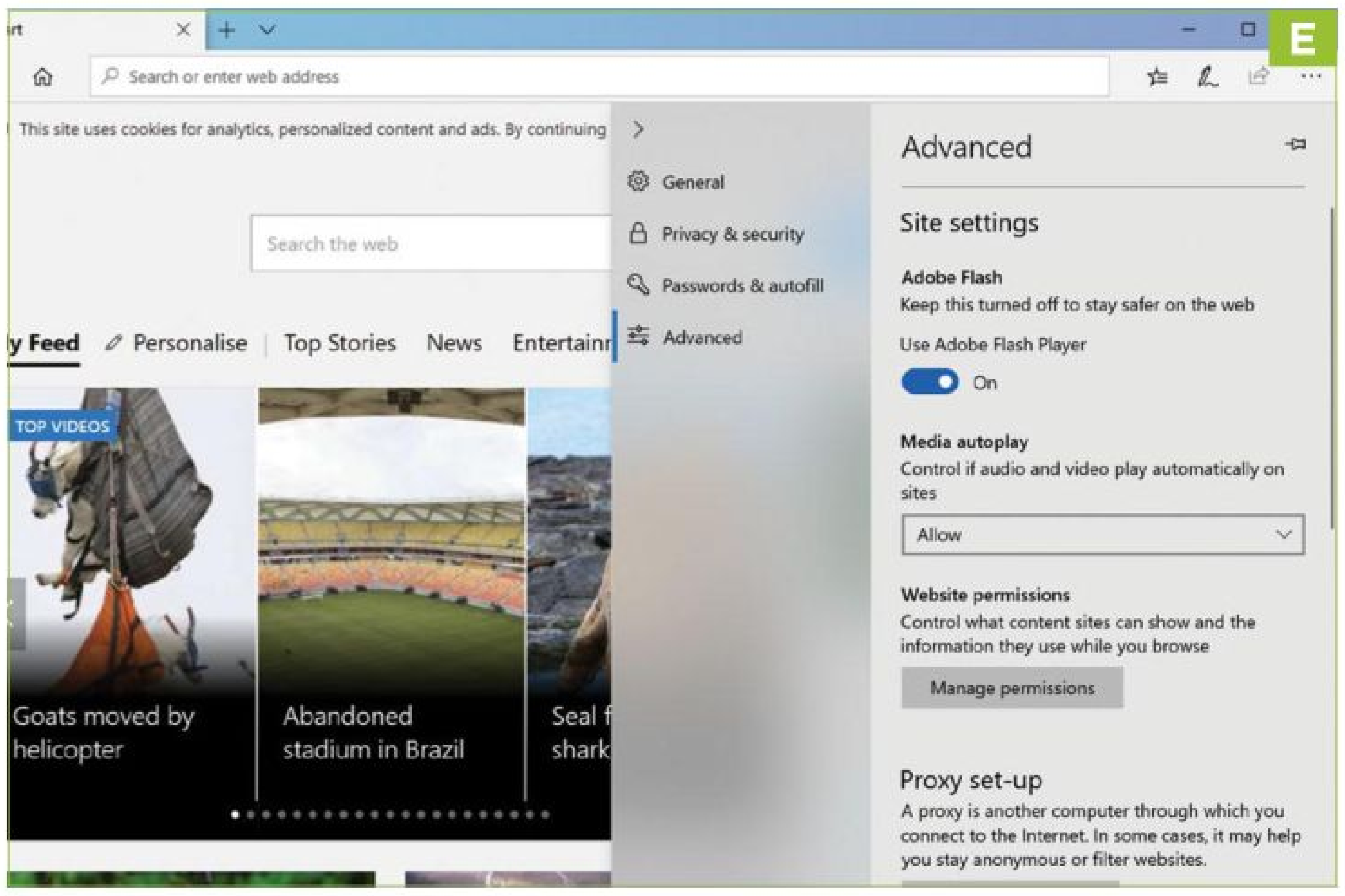
Use page prediction
This speeds up browsing, improves reading and makes your overall experience better
On

Security

Block pop-ups: On

Windows Defender SmartScreen
Keep me protected from malicious sites and downloads with Windows Defender SmartScreen.
On

© MICROSOFT


E
Search or enter web address
This site uses cookies for analytics, personalized content and ads. By continuing
Search the web
y Feed
Personalise
Top Stories
News
Entertainr
TOP VIDEOS
Goats moved by helicopter
Abandoned stadium in Brazil
Seal f shark
General
Privacy & security
Passwords & autofill
Advanced

Advanced

Site settings

Adobe Flash
Keep this turned off to stay safer on the web

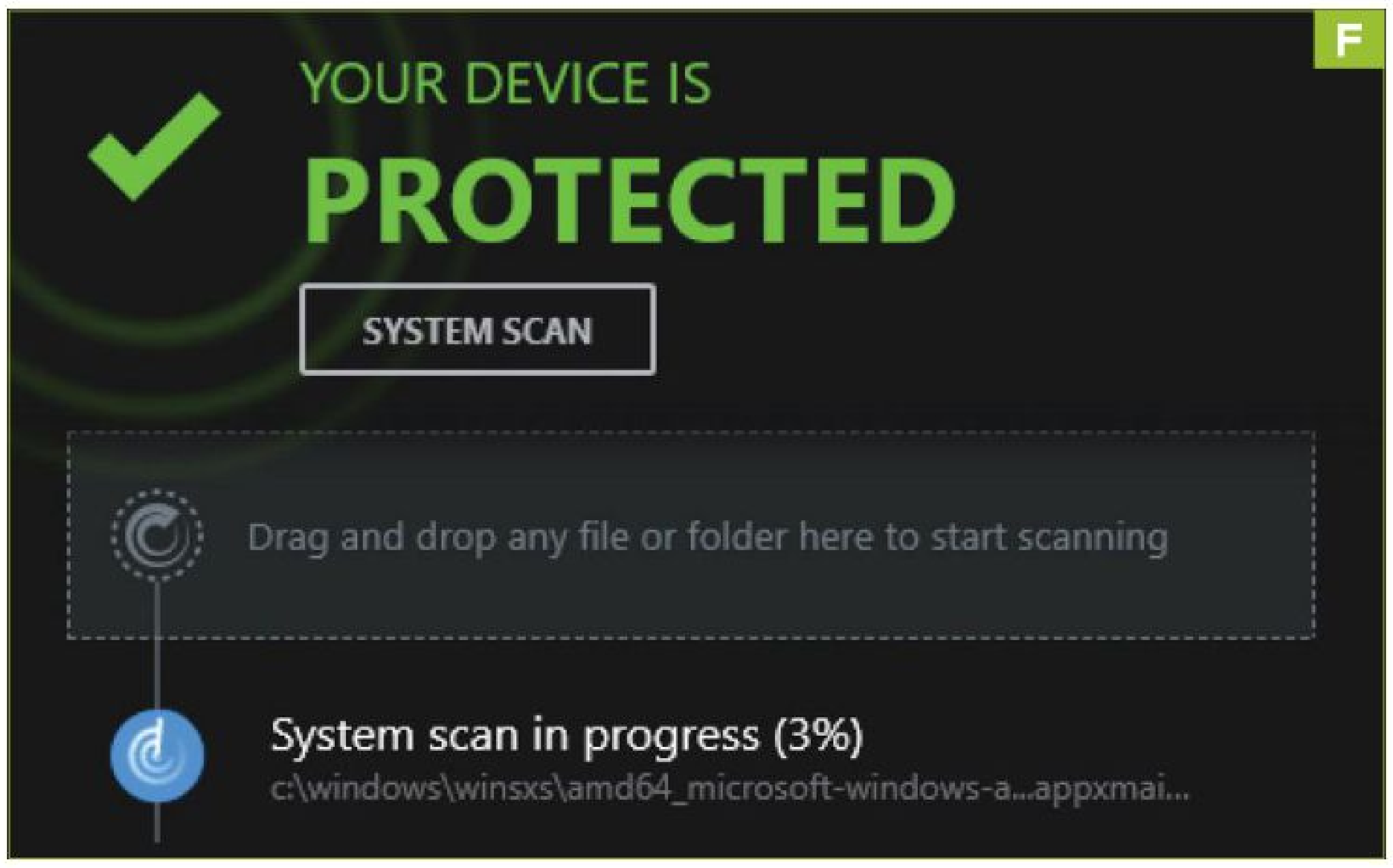
Use Adobe Flash Player: On

Media autoplay
Control if audio and video play automatically on sites
Allow

Website permissions
Control what content sites can show and the information they use while you browse

Manage permissions

Proxy set-up
A proxy is another computer through which you connect to the Internet. In some cases, it may help you stay anonymous or filter websites.

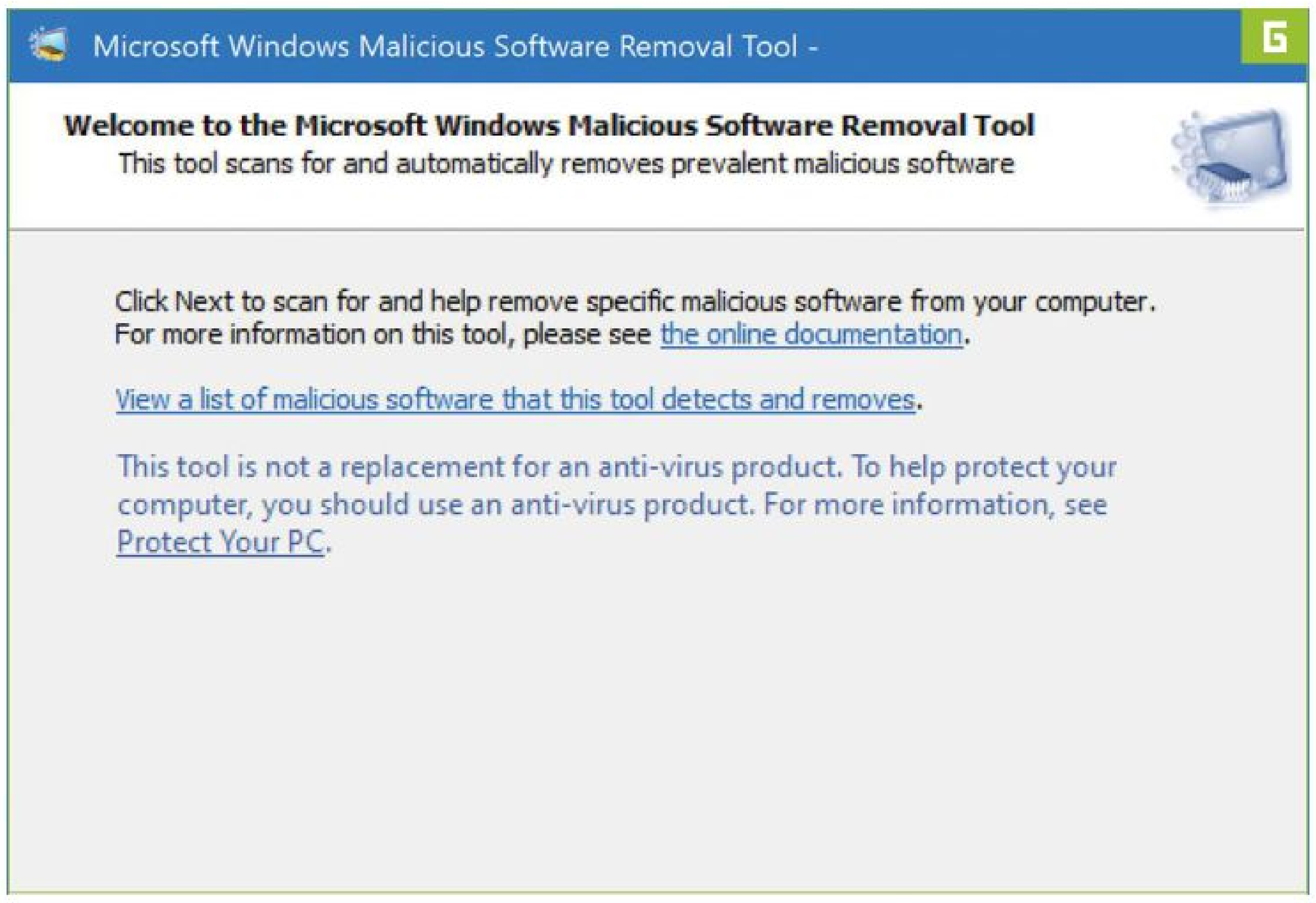

F

YOUR DEVICE IS PROTECTED

SYSTEM SCAN

Drag and drop any file or folder here to start scanning

System scan in progress (3%)
c:\windows\winsxs\amd64_microsoft-windows-a...appxmai...

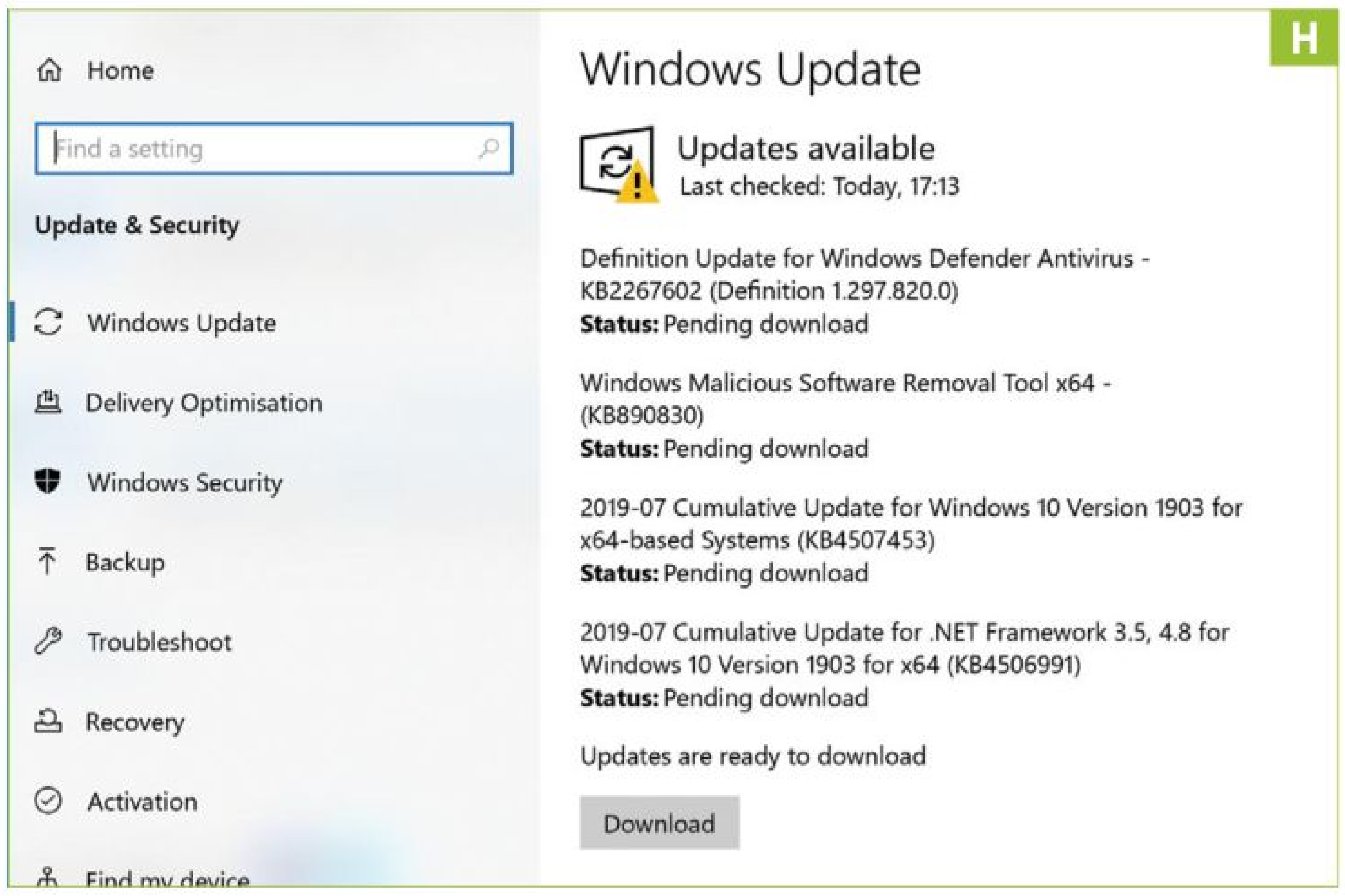

G
Microsoft Windows Malicious Software Removal Tool -

Welcome to the Microsoft Windows Malicious Software Removal Tool
This tool scans for and automatically removes prevalent malicious software

Click Next to scan for and help remove specific malicious software from your computer. For more information on this tool, please see the online documentation.

View a list of malicious software that this tool detects and removes.

This tool is not a replacement for an anti-virus product. To help protect your computer, you should use an anti-virus product. For more information, see Protect Your PC.


H
Home
Find a setting
Update & Security
Windows Update
Delivery Optimisation
Windows Security
Backup
Troubleshoot
Recovery
Activation
Find my device

Windows Update

Updates available
Last checked: Today, 17:13

Definition Update for Windows Defender Antivirus - KB2267602 (Definition 1.297.820.0)
Status: Pending download

Windows Malicious Software Removal Tool x64 - (KB890830)
Status: Pending download

2019-07 Cumulative Update for Windows 10 Version 1903 for x64-based Systems (KB4507453)
Status: Pending download

2019-07 Cumulative Update for .NET Framework 3.5, 4.8 for Windows 10 Version 1903 for x64 (KB4506991)
Status: Pending download

Updates are ready to download

Clean Your PC for Better Performance

YOU'LL NEED THIS

CLEANING EQUIPMENT
A can of compressed air with nozzle tube, a microfiber cloth, and isopropyl alcohol.

WE'VE ALL BEEN THERE. Listening to the grind of fans inside a system that hasn't been taken apart since it was first built. Seeing that tell-tale build-up of dust on the rear I/O when you reach over to plug something in. Whether you're rocking a custom-built rig or a prebuilt system, it's always a good idea to keep it clean. Unfortunately, regularly cleaning your system can be pretty time-consuming, with a large number of pitfalls along the way. Moisture getting into components where it shouldn't, components refusing to detach when they should, and dust getting everywhere all provoke concern, sufficient to stop many from taking the time to keep their computers spick and span.

As with cars, planes, and relationships, failure to properly maintain your PC can lead to disaster. Dust build-up can jam or slow fans, or potentially get into motherboard connectors and impinge on their use. Too much dust in a system can also result in worse temperature management as the filters become clogged, which could lead to a fiery demise for your machine. The good news is that you really don't need much to get a good, clean system, and it might not take as long as you expect. With our handy step-by-step guide, you too can experience the joy of booting up your machine to be met with barely a whisper. –CHRISTIAN GUYTON

1 GET PREPARED

The first step here is the most important: Make sure that you've got a decent amount of space to work in. Ideally, you'll want to set your PC down on a table or floor—no carpet, though. Ensure there is nothing plugged in or turned on, then remove all the external panels from your system. Depending on your case, this may be just the two side panels, or it could be the top and front, too. Remove any dust filters as well; set these aside and clean them first, using a duster or dry cloth. If the case panels are dirty, you might want to wash them, too; this isn't going to improve your system's performance, but grubby fingerprints on glass panels can ruin the appearance of an otherwise aesthetically appealing build.

›› For the cleaning of the system itself, you're going to want three things: a can of compressed air, a small amount of 99 percent isopropyl alcohol, and a microfiber cloth (perhaps more than one of each if you're anticipating lots of dust inside your case). These can easily be purchased online or in computer hardware stores, and shouldn't cost too much. If you can't find isopropyl alcohol, there are specific thermal paste removers that are commercially available, but these can be expensive; lighter fluid works well instead. The compressed air should come with a thin tube to attach to the nozzle, which you need to clear out hard-to-reach spots inside your case. Read the instructions carefully; muscle memory may tell you to shake the can like an aerosol, but usually you shouldn't do this, because it will cause the small amount of liquefied gas inside the can to be ejected, potentially damaging your system's delicate components.

2 CLEAN THE COMPONENTS

If you regularly clean your system's internals, you won't necessarily have to disassemble it fully to clean it. A quick blast of compressed air here and a wipe down there, and you'll be able to keep the build-up of dust at bay. Generally speaking, we recommend that you crack open and dust down your computer at least once a year, or every six months for small systems, which can accumulate dust faster.

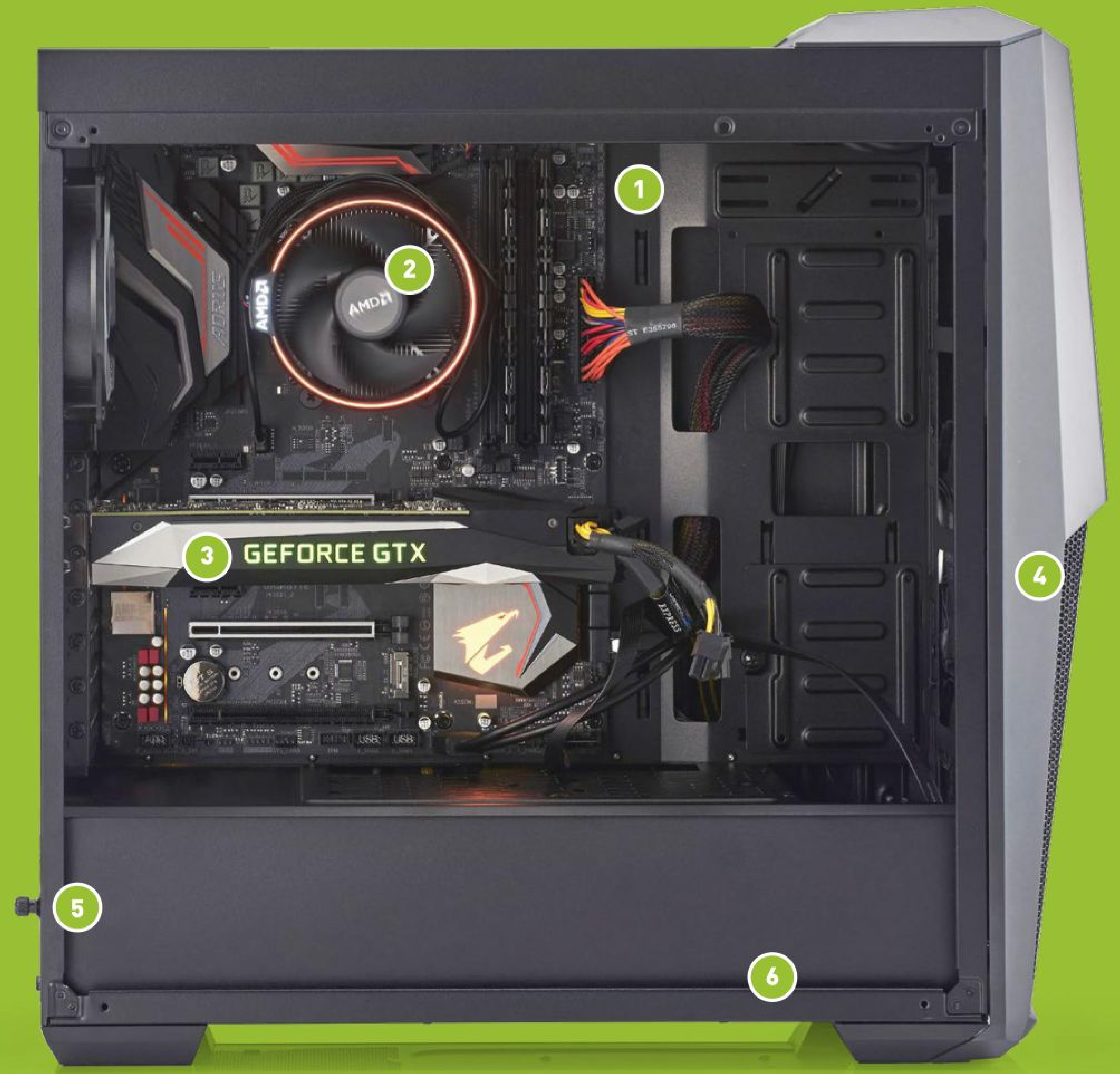
›› If this is the first time cleaning your system in over a year, however, follow our guide to ensure that your system is as clean as it can be. You'll want to start by removing the graphics card, RAM, and any other expansion cards plugged into your board. M.2 drives are usually fine to leave in place. If you've got a modular power supply, great; remove it and set it to one side. If not, you're going to need to unplug the power cables from the motherboard, and remove the whole PSU. Don't worry about drives or case fans for now.

›› For any solid sections of your GPU and memory, simply give them a quick wipe down with the microfiber cloth, being careful to avoid any exposed silicon or the delicate connectors toward the bottom. For the GPU fans, hold the compressed air can upright no less than an inch away from the fans, and give them a few short bursts, until any visible dust has been removed. Do the same for your PSU, then place the clean components somewhere safe away from the main case, to prevent any additional dust getting on them.

3 PROCESSOR AND PASTE

With your components cleaned, it's time to move on. Remove your CPU cooler (you can skip this part, custom liquid-loop users) and set it to one side, then carefully extract the CPU itself and lay it on a clean, flat surface. We say "carefully" because it'll be caked in conductive thermal paste, which stains clothes and fingers alike. It's not toxic to humans in small amounts, but we still recommend washing your hands afterward. If you've got some thermal paste of your own—we recommend Noctua's NT-H1 compound—grab your bottle of isopropyl alcohol and a tissue or paper towel. Put a little of the fluid on to the tissue and use it to wipe the old thermal paste off the processor and the cooler plate, then set them aside when you're done. You need to reapply a pea-sized drop of paste to the CPU when you reassemble your system later on, so if you don't have any thermal paste to hand, we advise that you just set the processor aside and continue to use whatever paste was already on it from before.

WHERE TO FOCUS YOUR EFFORTS



1. MOTHERBOARD
Be sure to place the nozzle tube of your compressed air can under the edges of the motherboard to clear out any unseen dust that may be have been gathering there for years.

2. THERMAL PASTE
You don't have to clean and replace the thermal paste on your processor every time you clean your PC, but it does degrade over time, so it's worth checking once in a while.

3. ADD-ON CARDS
Remove large components, such as soundcards and GPUs, for cleaning.

4. CASE COMPONENTS
Ports, case fans, and dust filters that are built into your case should always be cleaned last.

5. POWER SUPPLY UNIT
If you're lucky enough to own a modular power supply, you can remove it without having to unplug any cables from the motherboard first.

6. PSU SHROUD
If the case has a PSU shroud, be sure to approach from the other side and clear out the dust underneath it—after you've dusted the motherboard, that is.

4 AIR FORCE

With that done, it's time to start cleaning your system proper. Start off by holding the can of compressed air upright outside the case and giving the motherboard and other remaining components a few quick blasts of air to clear out the initial layer of dust, then attach the nozzle tube and start to work your way around the inside of the case. Always make sure that the end of the tube is at least one inch from the surface you are spraying, and be sure not to hold the can upside down or tilt it more than 90 degrees from upright, because this can cause liquid to be expelled from the nozzle.

›› Be thorough. You shouldn't need to remove the motherboard and drives from the case, but make sure that you dust underneath them. Be sure to only use short, sharp bursts of air. The can may become very cold while you clean; this is normal, but if it gets too cold to comfortably hold, use shorter bursts of air. Once you are satisfied that you have blasted every last bit of dust away from your components, the last step is to use the compressed air to dust the case fans and any integrated dust filters your case may have. If you can't remove them to clean them separately, they should be blasted with compressed air from the inside, after you have cleaned the rest of your system (start with these, and you'll find them clogged with dust again by the time you've finished).

›› Finally, it's time to reassemble your system. Don't forget to reapply the thermal paste to your processor if you've cleaned it, and replace any dust filters to your case. If there is dust build-up on the motherboard's rear I/O, you can use a cotton swab and a small amount of isopropyl alcohol to wipe it down. Replace the case panels and give yourself a pat on the back, then mark a reminder on your calendar to do this again in nine months' time. ⏻

Use Layer Styles for Great Text Effects

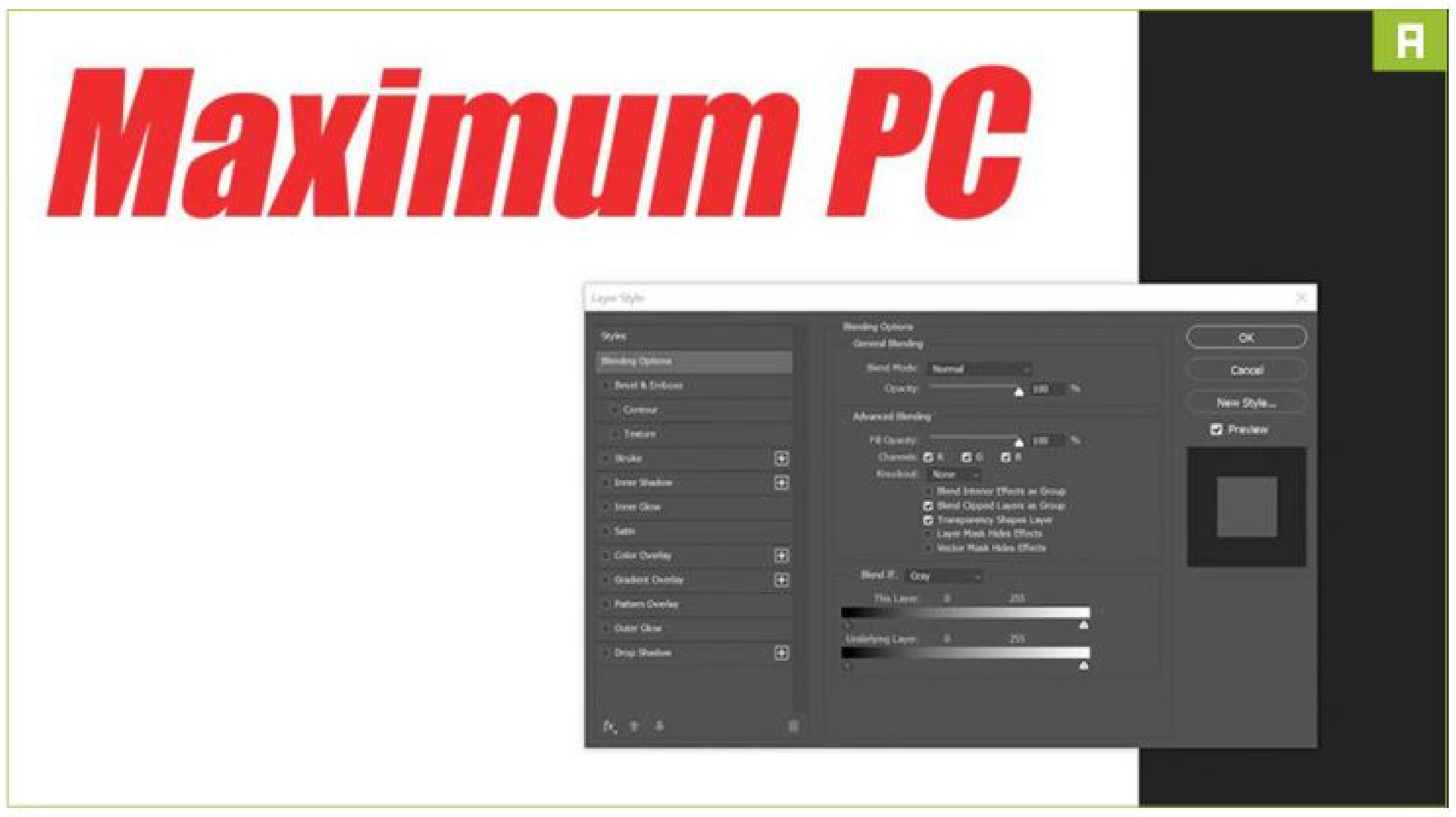
YOU'LL NEED THIS

ADOBE PHOTOSHOP
You can subscribe to a suitable package at www.adobe.com.

LAYER STYLES HAVE BEEN AROUND in Photoshop for a while, but remain one of its most powerful features. They come in two flavors: the sort you click on once to get a particular effect, and the sort you spend ages painstakingly fine-tuning with small movements of sliders.

When you create a Layer Style, you're using the edge of a layer—always a floating one, the Background layer won't do—to guide an effect. This can be a drop shadow, a glow, a complete pattern fill constrained to the shape of the layer, or a beveling effect to provide a 3D look.

One of the sad things about Photoshop Elements, the cut-down little brother to full-fat Photoshop, is that it doesn't implement Layer Styles in the same way or with the same enthusiasm. We're using the latest version of Photoshop CC for this, but it's an old technique, so can be applied to almost any edition from the last five years or more. **–IAN EVENDEN**

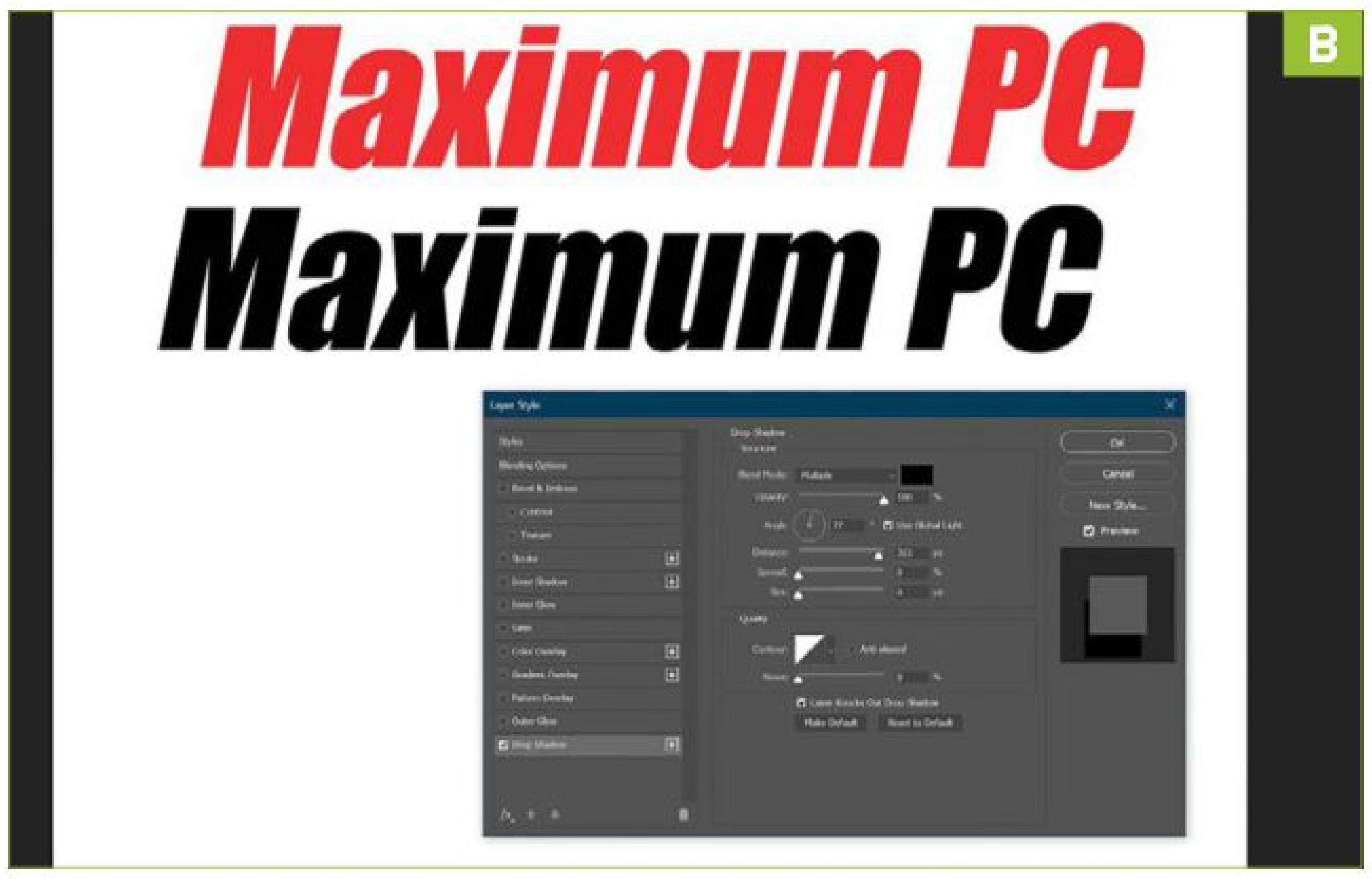


1 THE LAYER STYLES WINDOW

Open a new document in Photoshop, and create a layer. We've gone for a type layer, but you can draw a shape as well if you want to. Just as long as it's a floating layer and it has some content, it doesn't really matter. Now double-click that layer, on the right, away from its name. The Layer Style window should open [**Image A**]. If you end up renaming the layer, you've clicked too close to its name. You'll see a list of effects, each with a checkbox to their left, and some with a "+" to their right. The checkbox must be checked to see the effect—unchecking it turns it off even if you've made changes. The "+" adds an additional instance of that effect—so, for example, you can build up multiple drop shadows. There's a trashcan at the bottom of the window for deleting unwanted effects, and arrows for adjusting the stacking order.

2 DROP SHADOW

The drop shadow is one of the most basic effects you can add, and it works particularly well with text. It's at the bottom of the list, but we're going to put it first. Stick a check in the checkbox, and the sliders become active. Set "Opacity" to 100, "Spread" and "Size" to 0, then increase "Distance" until a black copy of your layer emerges from behind the original [**Image B**]. This is your shadow, and you can use "Opacity," "Spread," and "Size" to soften it from this plain black beginning. Of course, it doesn't have to be black—there's a square (black, by default) that you can click to change the color. The circular "Angle control" under "Opacity" controls which direction the light is coming from, enabling you to move your shadow around with a great deal of control.

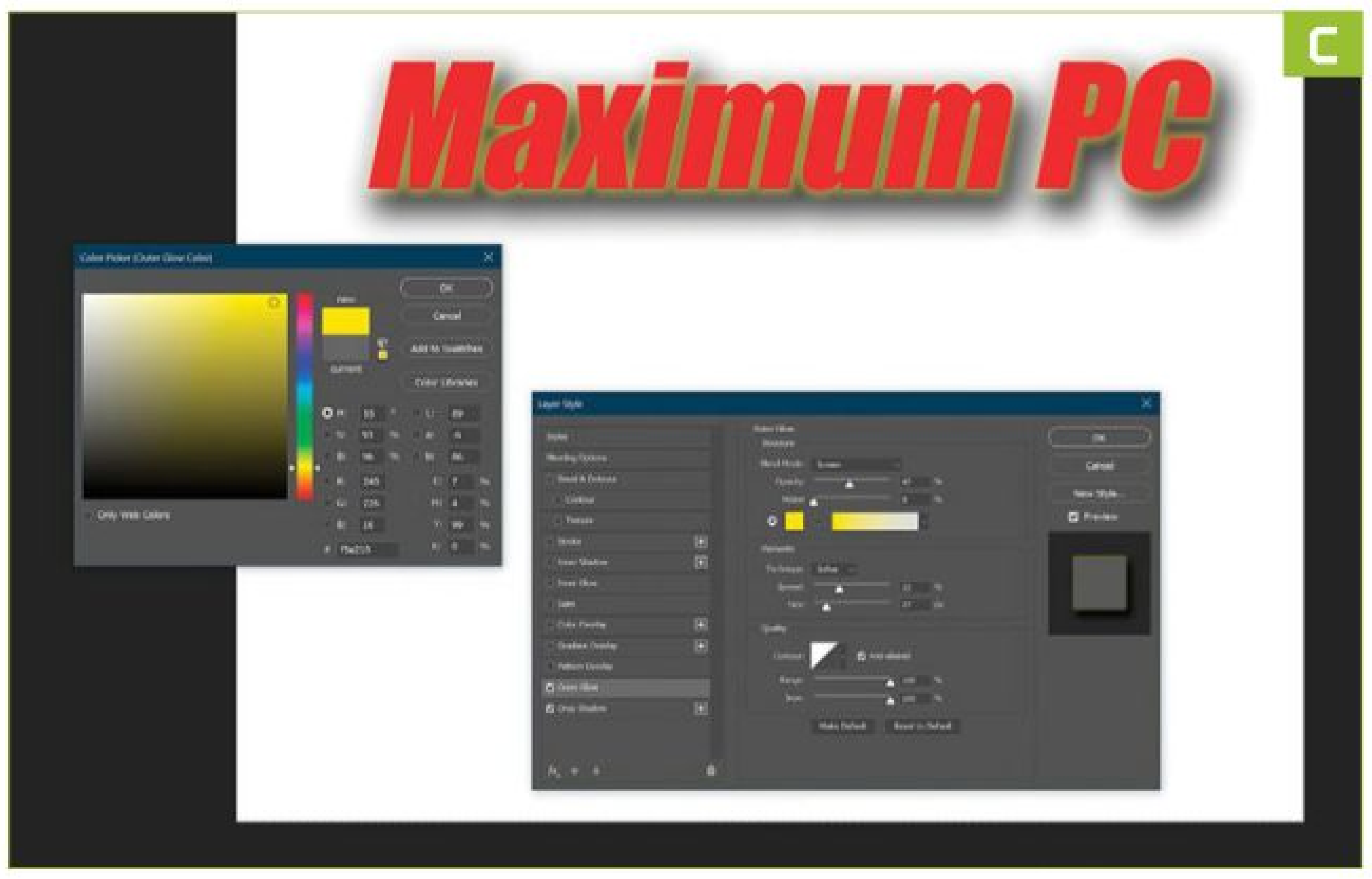


3 OUTER GLOW

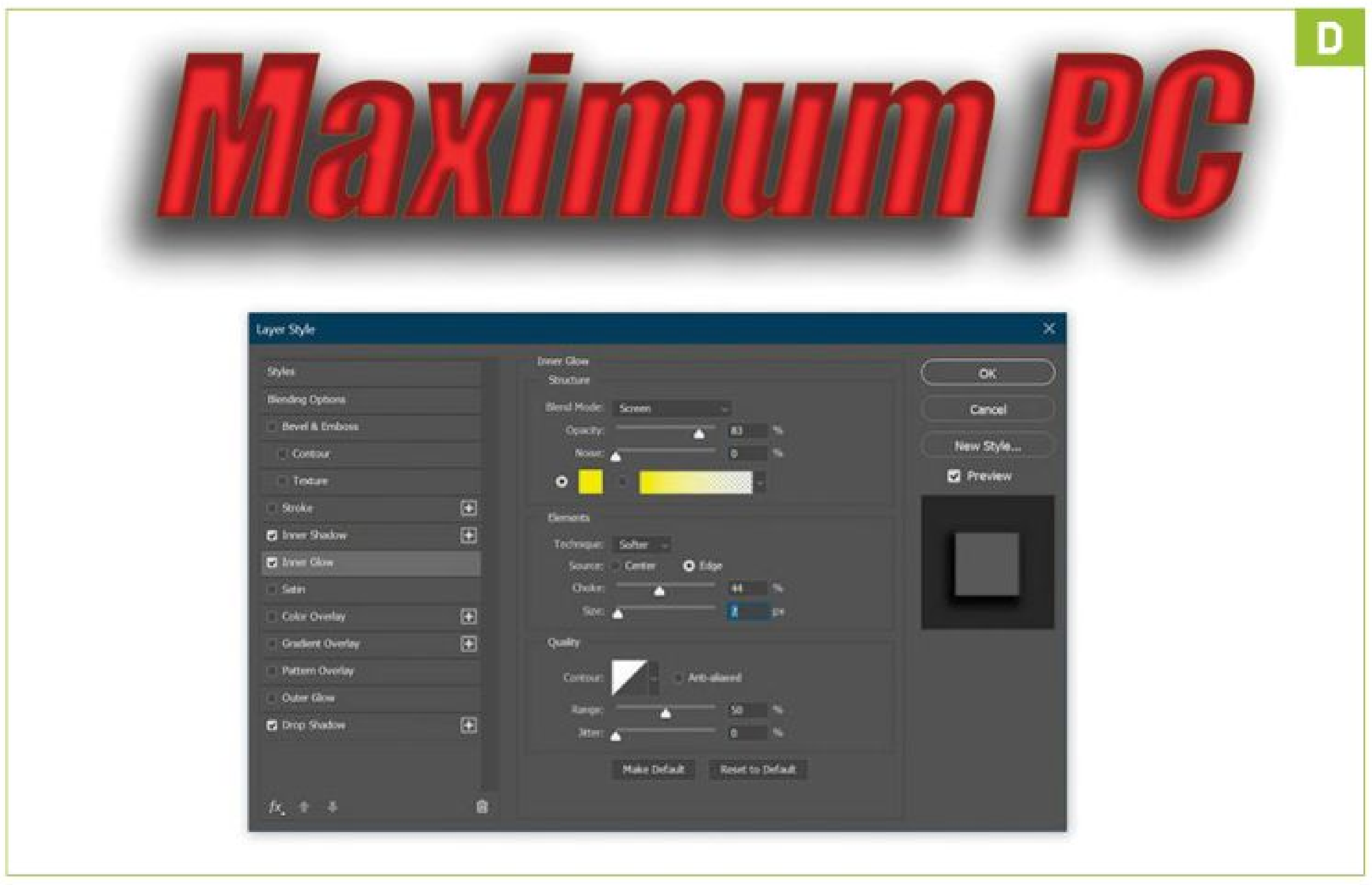
The next effect up from the bottom of the window is another great one for dealing with text. It does what you'd expect—creating a glow that spreads outward from the edge of your layer under your control. Set the color and Blend Mode (usually "Screen," because this lightens colors below as a glow would), then use the "Spread" and "Size" sliders to control how far the glow extends [**Image C**]. There are two "Techniques," available from a drop-down menu, but we always prefer the look of "Softer" over "Precise," as a glow should spread softly.

4 INTERMISSION: THE LAYERS PALETTE

It's worth taking a look at the Layers palette before we go further. Every Style you add to a layer is given its own entry in the palette beneath the



© ADOBE PHOTOSHOP



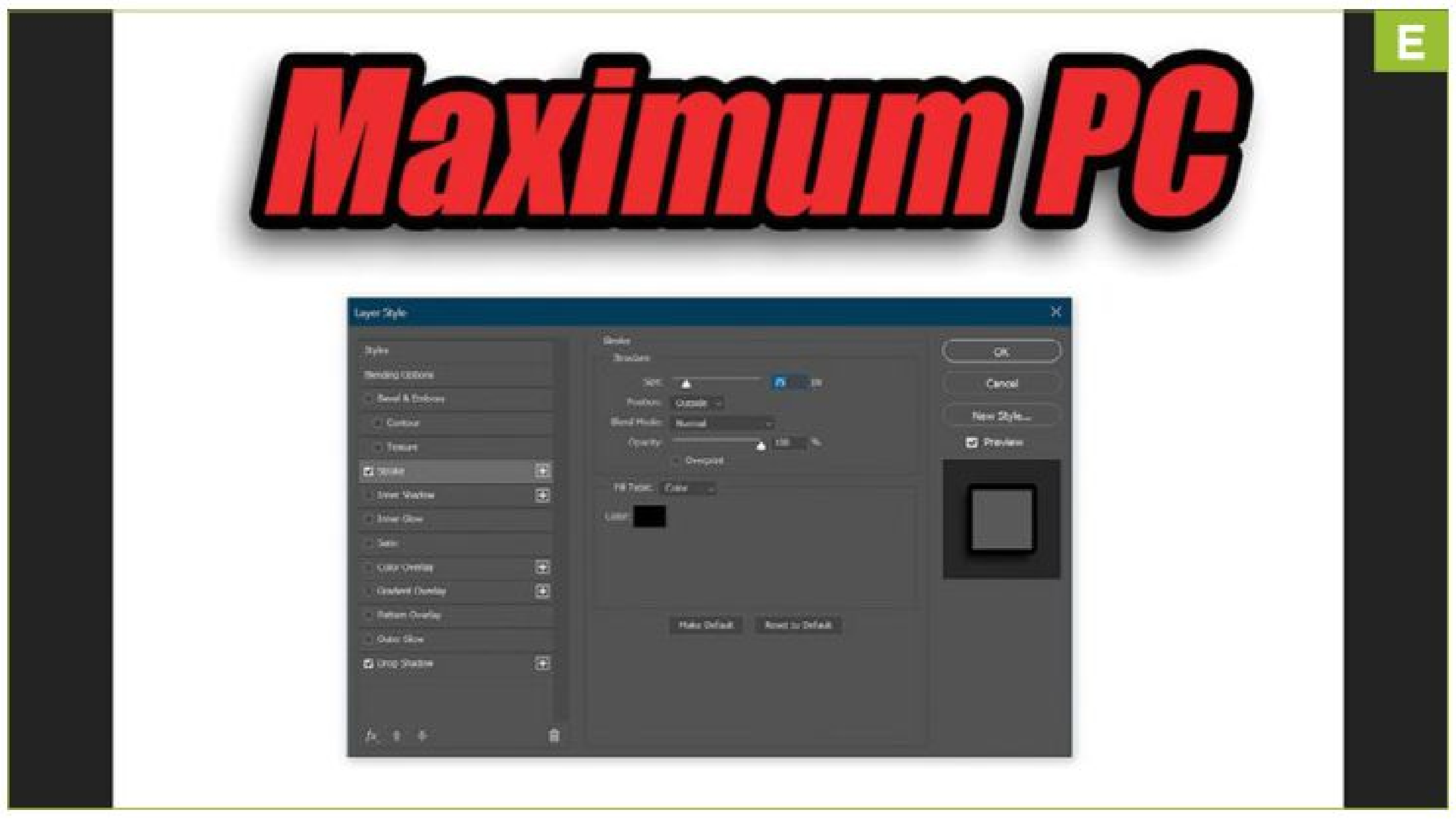
layer it applies to. Double-click each one to be taken to the Layer Styles window that edits that effect. Each one also has an eye icon to its left, which works in the same way as the eye icons against the layers—toggling their visibility on and off. There's also an "Effects" entry, with an eye icon that turns all effects on and off. The FX icon that appears to the right of the layer entry also opens the Layer Styles window if you double-click it.

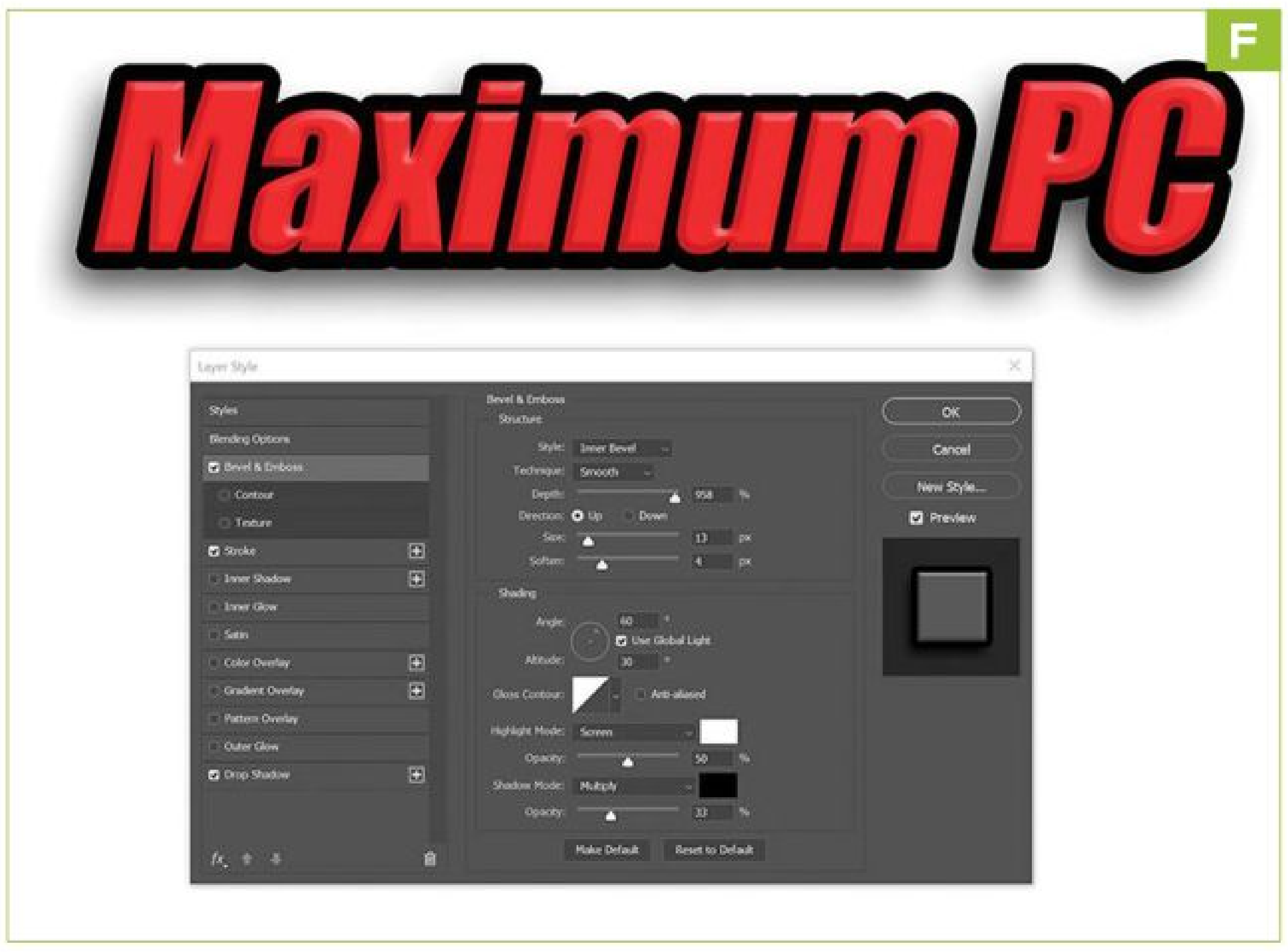
5 OVERLAYS

"Pattern Overlay" fills the layer shape with a pattern, as you'd expect. Photoshop's built-in patterns are rather low-res, so you're often better off creating your own or importing one. Even with a low-res pattern, you can get some interesting results from changing the Blend Mode. "Gradient Overlay" does much the same thing, except with a gradient that blends from one color to another. Or more. There's a number of preset gradients, but making your own is the way to go, and the Gradient Editor window has comprehensive tools for doing just that. The final overlay—"Color Overlay"—fills your layer with a specific color and allows you to blend it. "Satin," the next option on our journey up the window, is a combination of "Color Overlay" and "Gradient Overlay" that lets you choose the color and lighting angle. It really can look like a soft material texture if you get it right.

6 INNER GLOW AND SHADOW

These are the mirror universe counterparts of "Outer Glow" and "Drop Shadow." Their effects are anchored to the inner edge of your layer; with the right combination of slider settings, you can extend them a long way within. As a rule, glow lightens and shadow darkens, and there's a clever "Global Light" checkbox on "Inner Shadow" that means, if you've already set a lighting angle elsewhere, it will adopt it, saving you the trouble of lining the two up [**Image D**]. You can, of course, have two shadows cast at different angles if you want to, but Copernicus might spin in his grave slightly.





7 STROKE

A stroke is a line, and checking the box for this Layer Style draws a line around the edge of your layer [**Image E**]. You control its color and thickness, and can set its Blend Mode, too. While usually you'll want a solid color, it's possible to fill the stroke with a pattern or a gradient. You can place the stroke on the outside of the layer's edge, on the inside, or centered on it.

8 BEVEL AND EMBOSS

The ruling duo of the Layer Styles world, these sit at the top of the list [**Image F**]. They create a 3D effect with the addition of shadows and highlights, and there's a huge number of ways you can bring the options together. To start, there are five Styles available from a drop-down. Then a "Depth" slider controls the strength of the effect. You can choose the direction of the effect, then use the "Size" slider to set how many pixels across the effect covers. Your lighting angle can again be global, and you can blend the highlights and shadows separately, assigning different Blend Modes and opacities. It's a lot to take in, and can be made more complex with the "Contour" and "Texture" options that have their own checkboxes and sliders. The best thing to do is experiment, and develop a feel for what effect a particular combination of settings will produce. ⏻

STYLES ALIVE

Layer Styles are "live" effects, which means they're recalculated when the layer they've been applied to changes. This means you can completely rewrite your text, and as soon as you press the green check mark, your Styles are recalculated to fit the contours of the new lettering. If you place new objects on a layer, they may inherit the Styles you've already applied to it, so it's good practice to be disciplined in keeping objects separated between layers. You can always rasterize a layer by right-clicking it and choosing the appropriate option from the menu, but this removes any ability to edit the layer again in the future. Layer Styles can also be copied between layers, by right-clicking the style's entry on the Layers palette, selecting "Copy Layer Style," and using "Paste Layer Style" on a different layer. There's also a "Global Light" option on the right-click menu, meaning you can spin your light source around, and watch the changes it makes to all your Styles that are light-dependent.

BUILD IT

CHRISTIAN GUYTON, STAFF WRITER

A Super Gaming Machine for $2K

The new RTX Super cards from Nvidia seem almost too good to be true—let's put one to the test in a gaming build

LENGTH OF TIME: **2-3 HOURS** LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

NVIDIA'S "SUPER" VARIANTS of the GeForce RTX range have proved divisive, with some loving the improved performance sans price increase, while others disparage the modest performance gains. For our money, the Super cards are pretty good; however, the 2060 Super loses points for costing $50 more than the original 2060, and the 2080 Super doesn't hit the 4K performance levels we wish it could. That leaves the RTX 2070 Super, our personal favorite, and arguably the best 1440p GPU on the market. The Super version performs about 15 percent better than the original RTX 2070, and it doesn't cost a cent more.

That card is the focal point of this build, a future-proofed system designed to handle high-quality 1440p gaming for years to come. That means we're looking at a cut above the usual components, although we've tried to trim costs in other areas. With a target price of $2,000, things were tight; we're still pushing the new generation of PCIe 4.0 components, which drives up the price across the board—no pun intended.

As you might expect, we're dealing exclusively in ultra graphical settings. Our goal was to create a system capable of running just about any game at 1440p ultra, at 60fps or better. That includes new releases—with the likes of *Cyberpunk 2077* and (hopefully) *Death Stranding* on the horizon, this rig needed to be capable of handling future titles. Versatility was a factor, too. A system that is difficult to upgrade is nobody's friend, so potential for easy expansion and improvement was a must. So here we go: What should be a straightforward build. Was it, though? Read on….

SUPER-POWERED

IN ADDITION TO THE BELLE of this ball, Zotac's Gaming RTX 2070 Super AMP Extreme, this system is packing some pricey parts. At the center is the new Ryzen 7 3800X from AMD. If you're planning on building this system, we recommend waiting until this CPU is back in regular stock; some resellers are exploiting product shortages to charge exorbitant prices for the 3000-series Ryzen chips.

That processor is going on an X570 motherboard, ASRock's X570 Taichi. The steampunk appearance and low-key RGB lighting matches well with the LEDs of our AMD Wraith Prism cooler—the stock cooler for the 3800X, which performs admirably despite coming with the chip at no extra cost. Next is memory; we've opted for two DIMMs of G.Skill Trident Z at 3,200MHz. We did contemplate using two 8GB sticks, but decided that 32GB was a more reliable long-term choice, so opted for the 2x 16GB kit instead.

Storage-wise, we've chosen a 1TB Corsair MP600 M.2 SSD, an NVMe Gen4 drive that will provide speedy transfers. There's potential for easy storage upgrades here; the BitFenix Saber case we're using has a drive cage with slots for two 3.5-inch HDDs, or mountings for up to eight SATA SSDs. Aside from that, the Saber also comes with two case fans and some fairly neat RGB lighting on the front panel. There's a strange little plastic cover over the triangular power button, too—we're not sure what purpose that's supposed to serve. A shield against rage-quits, perhaps?

Lastly, we're powering this rig with a Corsair RM750x PSU. 750W is superfluous for such a system, but it leaves room for upgrades without needing to replace the power supply. The RM750x's modular design makes installation easier, too; a must-have feature, given that the Saber's drive cage is welded to the base, leaving little room for errant cabling to be tucked away.

INGREDIENTS

PART		STREET PRICE
Case	BitFenix Saber	$95
Motherboard	ASRock X570 Taichi	$300
CPU	AMD Ryzen 7 3800X	$399
CPU Cooler	AMD Wraith Prism (stock cooler)	N/A
Memory	32GB (2x 16GB) G.Skill Trident Z 3,200MHz	$248
GPU	Zotac Gaming GeForce RTX 2070 Super AMP Extreme	$499
PSU	750W Corsair RM750x 80+ Gold	$140
Storage	Corsair MP600 Force Series Gen4 1TB M.2 SSD	$219
OS	Windows 10 Home 64-bit	$100
Total		$2,000

1 GETTING PREPPED

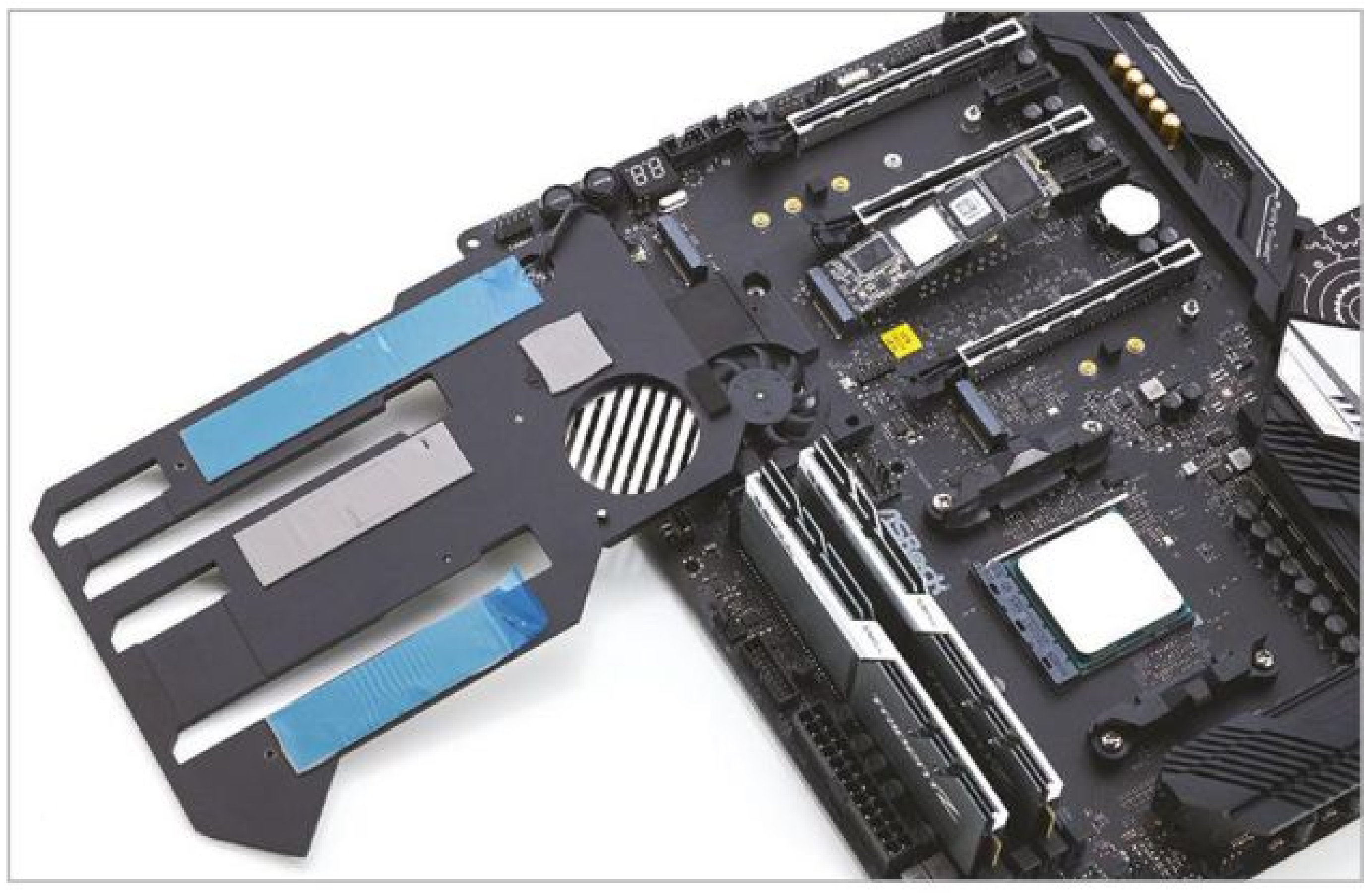
AS USUAL, we start with a full case stripdown. There are a lot of cables to contend with, and not much space to work in. Remove both side panels, but leave the main bundle of cables from the front I/O tied up; they'll only get in the way otherwise. What you do need to do is untie the cables from the case fans, and feed them through to the back of the motherboard mounting plate, removing any slack inside the main case cavity that will hinder the installation process. Lastly, be sure to remove the cardboard box from the drive cage tray, because this contains some screws and cable ties we'll use later on.

2 IN MEMORIAM

BEFORE WE SITUATE the motherboard inside the case, we'll need to install some components on it. First up is the processor. This is a cinch if you've done it before, and easy enough if you haven't: Simply lift up the metal retention arm on the CPU socket, drop the chip into place—being sure to line up the gold triangle on one corner with the triangle on the socket—then lower the retention arm back down to secure the processor. With that done, it's time to move on to the memory. The X570 Taichi only has clasps on one side of the DIMM slots; open them, and fit the memory to slots A2 and B2 (these are the primary memory slots—use others, and the XMP profile for 3,200MHz is liable to fail). Push down on each stick until the clasp clicks into place, then push down on the opposite end to ensure that it is properly fitted.

3 HEATED DISCUSSION

THIS IS WHERE THINGS get more complicated. Both the M.2 drive and motherboard come with a heatsink and thermal pads for passive cooling of the drive; we're going to use the mobo's large heat spreader, although it can be removed. Remove the heatsink from the Corsair MP600 by pulling the clips on either side and levering the metal sink from the top of the drive. The drive may come with the sink as you remove it—simply peel it off the sticky heat pad. Next, remove the three Allen screws on the X570 Taichi's heat spreader and lift it up, taking care not to damage the attached cable (this powers the RGB lighting). Screw the MP600 down in the middle M.2 slot, then replace the heat spreader, remembering to remove the plastic cover on the sticky pad before doing so.



4 NOW BOARDING

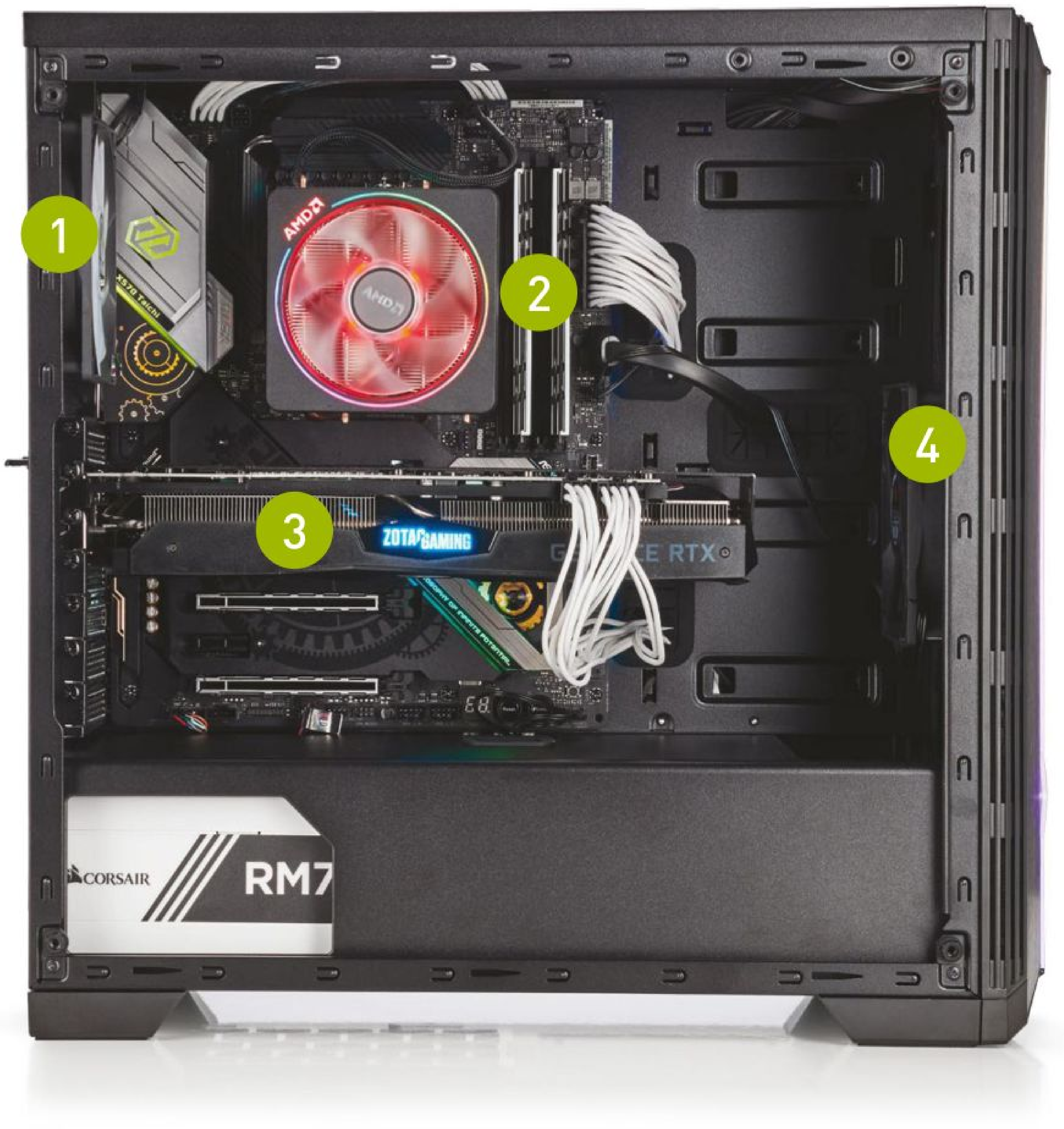
WITH YOUR COMPONENTS ATTACHED, it's time to situate the motherboard in the case. Lower the board in carefully, lining up the rear I/O, and fitting it to the central mounting peg. Using the screws from the Saber's accessory box, secure the board at the eight fastening points around the edges. This can be difficult, due to the relatively small size of the Saber and the bulkiness of the Taichi. Be careful not to drop the board; even though it has a heavy armored plate on the rear, other components don't have the same protection. Once the board is secure, untie the front I/O cables, and plug in all of them except the USB connector—we'll get to that later. You can also plug in the case fans—use the standard three-pin connector for the front fan, not the larger direct power connector.

5 COOL AND COLLECTED

THE LAST THINGS TO ADD to the mobo are the cooler and CPU. We're using the stock cooler for the Ryzen 7 3800X, the Wraith Prism. This attaches using a standard AMD cooler bracket, which should be pre-installed on most X570 boards. Put a small glob of thermal paste on the CPU, then attach the metal clasps to either side of the bracket, and pull the fastening lever across until it snaps into place. Don't forget to plug the power cable into the mobo's CPU fan connector, too. Once done, remove two blanking plates from the back of the case, then lower the GPU into the PCIe slot. Make sure it clicks into place, then screw it down with the thumbscrews from the blanking plates. The RTX 2070 Super AMP Extreme is a big card, so ensure it's secured before placing the case upright.

6 MODULAR MANAGEMENT

THE LAST STEP is to provide power. The Corsair RM750x is a large PSU, so you need to plug in all the necessary cables to the modular rear of this big white brick before you install it. In addition to the large motherboard power connector, you need an eight-pin CPU power connector, a GPU power cable that splits into an eight-pin and six-pin connector, and one SATA/accessory cable. Getting the PSU in can be a squeeze, although once it's screwed into the case, feeding through the cables is straightforward. Cable management can be a tall order in this case; there's not much room behind the motherboard, and the drive cage is riveted in place, taking up a fair amount of otherwise useful space for routing cables. This isn't likely to be the tidiest of builds, but with some cable ties and a mild amount of exertion, we can hide the bulk of the cables out of sight behind the motherboard.



1 This rear fan actually has RGB lighting, but there aren't enough RGB headers on the motherboard to support it.

2 Getting the G.Skill Trident Z memory running at its requisite 3,200MHz was simple enough, demanding only a quick trip into the BIOS to turn on the XMP.

3 Zotac's triple-fan take on the RTX 2070 Super puts power over presentation, with a basic black appearance, and only a softly glowing Zotac logo for lighting.

4 The front case fan can be easily removed, or supplemented with two additional fans—one above and one below.

HARDER THAN EXPECTED

PERFORMANCE-WISE, this machine did great. Even the demanding *Ghost Recon: Wildlands* was able to crack 60fps at 1440p max settings, and the high-end components comfortably outpaced the zero-point in our benchmarking software tests.

When we examine options for our monthly "Build It," the decisions are easy to make right now; the high-speed transfers of NVMe Gen4 SSDs make them an obvious choice, which necessitates the use of an X570 motherboard, and subsequently a Ryzen 3000 series CPU. We're not complaining, though, as the new Ryzen chips perform admirably, their only major drawback being a lack of significant overclocking headroom.

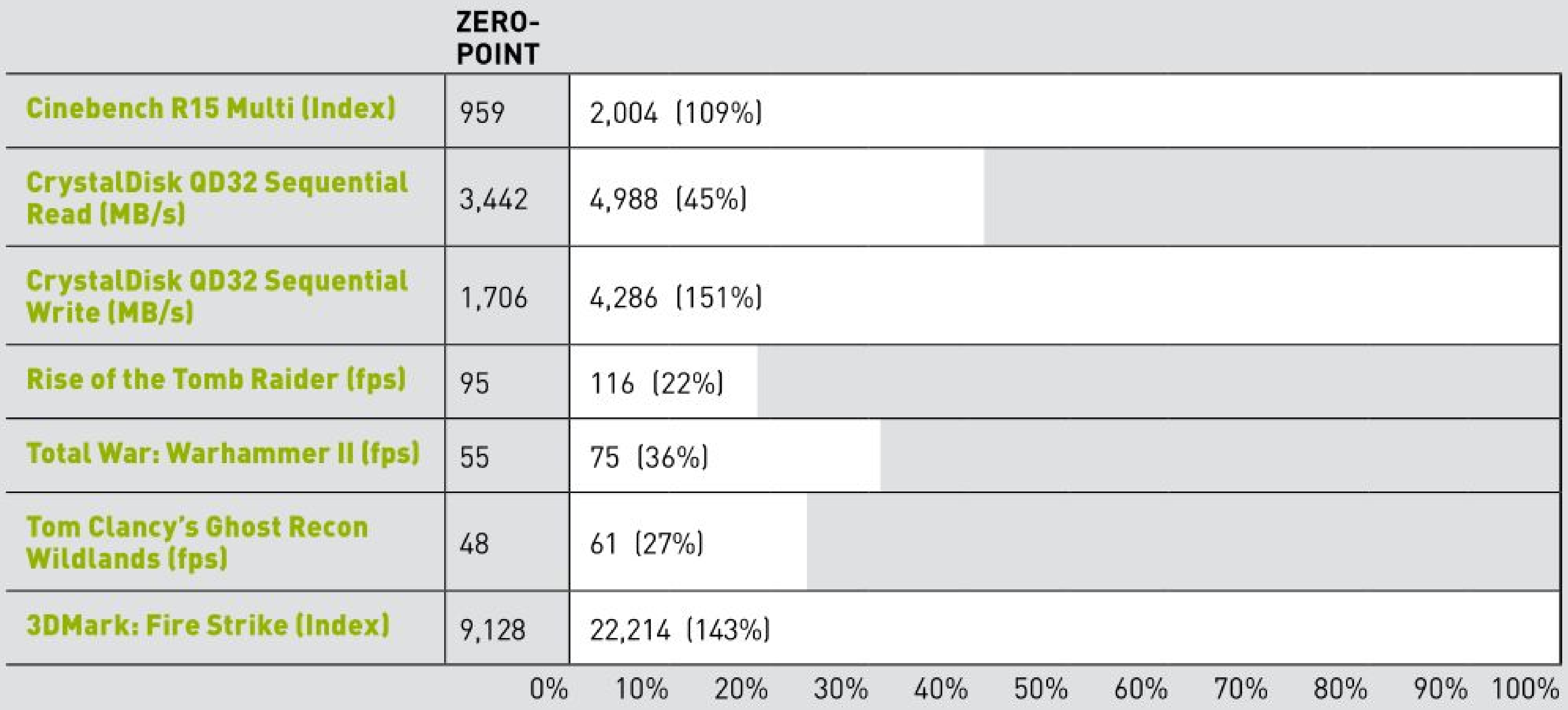
The downside with using these next-gen components is a lack of variety, but that should be resolved as more manufacturers put out their own takes. We often have to work with the hardware we have to hand, so feel free to swap out the motherboard or drive for the Gen4 model of your choosing. We recommend sticking with the Zotac RTX 2070 Super, though, as it's an excellent card, and a swathe of sales on the Super cards makes them a great purchase right now.

With hindsight, we might reconsider the use of the BitFenix Saber. While the symmetrical front lightbars look fantastic, and the $95 price tag is decent, considering the sturdy metal construction and tempered glass side panel, working inside it was a challenging experience. A lack of routes and holes for cables was a particular frustration. A smaller PSU might also have been a wise choice, as the chunky RM750x was a tight fit. There's no way we'd use a non-modular PSU in this case, though, due to the obstruction caused by the drive cage.

Speaking of which, one thing we definitely like is the potential for easily adding extra storage. The two drive cage trays can take a 2.5-inch SATA SSD or a larger HDD, and there's lots of space for other SATA drives in six mounting positions. There's also potential for easy RAM or GPU upgrades, but they shouldn't be necessary for a long time.

Although the Wraith Prism is very good, if you are planning on trying to overclock the CPU, you may wish to invest in a more robust cooling solution. The last point of contention is RGB lighting control. The X570 Taichi only has one header for RGB connections, which we hooked in to the Saber's front lightbars, leaving the rear fan unlit. The BitFenix hardware connects to RGB control software, but unless you're willing to buy a third-party controller, you're out of luck. ⏻

BENCHMARKS



	ZERO-POINT	
Cinebench R15 Multi (Index)	959	2,004 (109%)
CrystalDisk QD32 Sequential Read (MB/s)	3,442	4,988 (45%)
CrystalDisk QD32 Sequential Write (MB/s)	1,706	4,286 (151%)
Rise of the Tomb Raider (fps)	95	116 (22%)
Total War: Warhammer II (fps)	55	75 (36%)
Tom Clancy's Ghost Recon Wildlands (fps)	48	61 (27%)
3DMark: Fire Strike (Index)	9,128	22,214 (143%)

Our zero-point consists of an Intel Core i5-8400, 16GB (2x 8GB) of Corsair Vengeance LPX @ 2,666MT/s, an MSI GeForce GTX 1080 Armor, and a 500GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1440p at the highest graphical profile.

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REVIEWS

TESTED. REVIEWED. VERDICTIZED.

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Velocity Micro Raptor Z55

A combo of current components and old-school case

WITH MANY boutique builders out there, Velocity Micro stands out from the crowd in some interesting ways with its Raptor Z55. The front of the case has a dark brushed aluminum finish, and there's a cutout glass panel with a mesh vent beneath for airflow. It's an interesting design choice, seeing as most modern cases opt for a full tempered glass panel, but it's still a sleek full-sized case that's not too big, and not too bulky.

It manages airflow efficiently by pulling cool air from the bottom of the case—interestingly, this is enough to keep the entire rig cool without the aid of other fans at the front or back. The sides snap on and off from the case, instead of being secured by magnets or screws, but they go back on easily. The cable management is clean and crisp (no cluster of cables shoved in there like it's 1999), and the LED lighting is understated for those who prefer a glow to a lightshow.

The optical drive is the most unexpected feature on this high-end build. CDs are now near-obsolete, so there's no need for modern cases to accommodate them into their design. Cases that did so only a few years ago often had a front panel that swung shut to hide the optical drive, to give the case a cleaner appearance, so to see the optical drive front and center, like a '90s rig, is an odd design choice. Nostalgic, but not entirely practical for the modern PC gaming enthusiast. The Raptor Z55 feels like a sleeper in that regard, but Velocity Micro does have a mid-tower version of the Z55 without the optical drive.

The optical drive doesn't interfere with how the components are laid out, though, even with an optional cage on the inside that can hold up to five HDDs. The configuration we received boasts an AMD Ryzen 9 3900X, an RTX 2080 Super, 32GB of DDR4 3,200MHz RAM, a 1TB NVMe SSD, and a 4TB HDD—a great combination if you're looking to graduate from 1080p monitors and still experience smooth gameplay with high frame rates and refresh rates over 60Hz. You won't necessarily see 60fps at 4K with this CPU and GPU combo, even with ray tracing turned off, but together they pack a powerful enough punch to get close to or over 60fps on ultra with some of the most demanding games.

With our usual benchmarks, the Raptor Z55 spits out 3,282 in Cinebench, and 23,554 (1080p), 12,614 (1440p), and 6,584 (4K) in 3DMark, with a real-time ray-tracing score of 6,640 at 1080p. Moving on to the games, *Total War: Warhammer II* averaged 100fps (1080p), 85fps (1440p), and 51fps (4K) with the graphics set to ultra. *Division 2* averaged 109fps (1080p), 77fps (1440p), and 44fps (4K) on ultra, while *Metro Exodus* averaged 75fps (1080p), 59fps (1440p), and 38fps (4K) on ultra. With ray tracing turned on high at 1080p, *Metro* averaged 65fps.

Even the CrystalDiskMark scores are stellar—the NVMe SSD has a read/write score of 4,938MB/s and 4,283MB/s respectively. Those speeds won't improve frame rates, but they do decrease boot times and the time spent loading into the actual game from the menu.

As an extra bonus, every custom rig that comes from Velocity Micro is tuned to get the best performance out its components. Plus, its warranty covers lifetime phone support and lifetime labor coverage, with an optional up to three-year parts replacement warranty, and US-based call center support.

Now, down to the price—this build is $3,499 before shipping. Given the cost of the components individually, anyone can DIY with the same or equivalent parts for less. The added cost in this scenario is from the customer support and the convenience of not building it yourself, but it seems on the steep side compared to some other boutique builders. However, that's the only downside to an otherwise professional and understated build. **–JOANNA NELIUS**

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	2,178	3,282 (51%)
CrystalDisk QD32 Sequential Read (MB/s)	3,136	4,938 (57%)
CrystalDisk QD32 Sequential Write (MB/s)	2,126	4,283 (101%)
3DMark: Fire Strike (Index)	6,988	6,584 (-6%)
Total War: Warhammer II (fps)	42	51 (21%)
The Division 2 (fps)	42	44 (5%)
Metro Exodus (fps)	37	38 (3%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point consists of an Intel Core i9-7900X, 32GB of G.Skill Ripjaws V Series @ 3,000, an MSI GeForce GTX 1080 Ti, and a 512GB Samsung 960 Pro M.2 PCIe SSD. All tests were performed at 4K at the highest graphical profile.

VERDICT 8

Velocity Micro Raptor Z55

+ COOL Professional build; understated design.

− DROOL Unnecessary optical drive; price.

$3,499, www.velocitymicro.com

SPECIFICATIONS

Processor	AMD Ryzen 9 3900X 12-core, 3.8/4.6GHz
Graphics	Nvidia Geforce RTX 2080 Super 8GB
RAM	32GB DDR4 3200 Crucial Ballistix Sport
Motherboard	Asus ROG Crosshair VIII Hero Wi-Fi X570
Primary Storage	1TB Gigabyte Aorus PCIe 4.0 NVMe SSD
Additional Storage	4TB 7,200rpm SATA 600 HDD with 64MB cache
Cooling Solution	Velocity Micro 240 Liquid Cooler
PSU	850W EVGA SuperNOVA Gold Certified
Case	Raptor Z55
Warranty	One-year standard part replacement and lifetime labor

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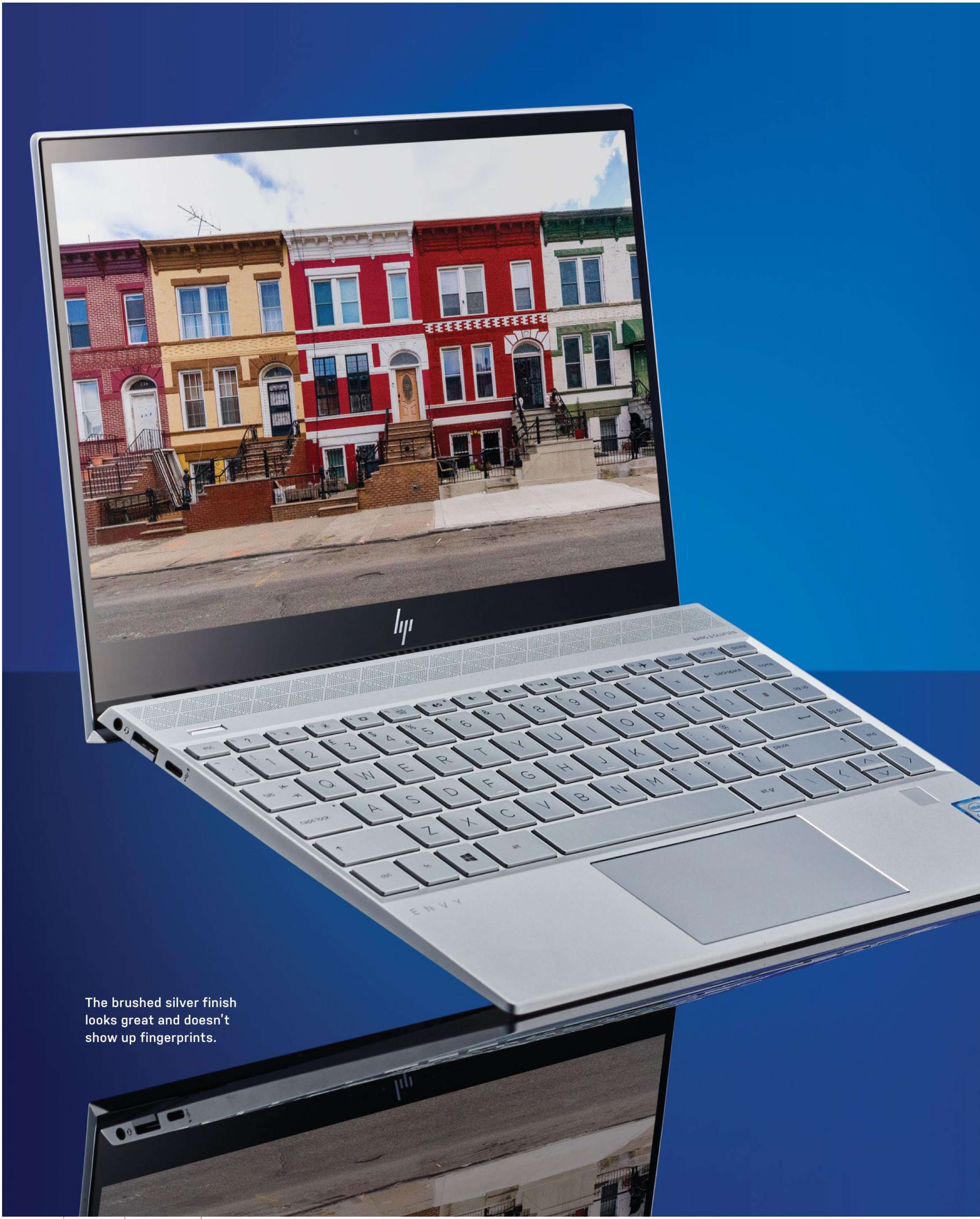


The brushed silver finish looks great and doesn't show up fingerprints.

HP Envy 13

Style and substance

WE TEND TO GET our hands on more beefy gaming laptops than ultralight notebooks here at *Maximum PC,* but that's not to say that we don't like a sleek, small, portable computer from time to time. The HP Envy 13 is one such example; picking it up, it's difficult not to immediately like this 14.7mm-thick silver rectangle. HP has long been one of the frontrunners in the battle for the best ultralight laptop, and the company's latest effort proves that the kid gloves are off, and HP is playing for keeps.

Unlike many laptops in its class, the Envy 13 is rocking a discrete GPU. It's nothing too impressive—an Nvidia GeForce MX250 with 2GB of VRAM—but it's just enough to give it an edge over the many other notebooks aimed at professionals on the go, which have to rely on integrated processor graphics. No, you're not going to be playing any triple-A titles on max settings here, but the discrete graphics card can improve performance in certain photo and video-editing apps. Our review model comes with 16GB of RAM and a quad-core i7-8565U processor, which also serve to stand this machine in good stead, if not totally blow us away.

A quick peek at the benchmark figures might at first appear to show lackluster performance in graphical areas against our zero-point, but the Asus GL502VS we're comparing it to is a far more powerful laptop, equipped with a GTX 1070 GPU. Considering that the Envy 13 is half the thickness and weight, this is a fair trade-off. The Envy 13 also has an M.2 SSD for faster read and write times, and can use Intel's own Turbo Boost Technology to theoretically push the 1.8GHz CPU as far as 4.6GHz. Although we didn't quite reach that figure in our own tests (4.4GHz was the highest we saw), the processor performance is still impressive, and the Envy 13 comfortably outperforms similarly priced ultralight laptops in popular benchmarking software, such as 3DMark, PCMark, and GeekBench 4.

So, performance isn't a problem, but designing a high-quality ultralight system is about more than what's inside, so let's have a gander at the external chassis. The initial inspection is reassuring. The smooth metallic finish and white backlighting on the chiclet keyboard look great. The upper half of the laptop has a bend at the base that pushes the bottom half up slightly at an angle when the screen is open. This feature is quickly becoming more common in notebook design, because it serves both to angle the keyboard up toward the user and provide more air space beneath the chassis to improve cooling.

The touchpad feels a little flimsy, but that's not unusual for ultralight laptops, and on the whole our review unit feels sturdy enough. The 1080p touchscreen is covered with Corning Gorilla Glass, the bezel surrounding it is satisfyingly tiny, and a quick peek at the underside of the chassis shows the cool triangular cooling ports. The good design choices don't stop there, either. The Envy 13 was designed with digital security in mind, so the usual fingerprint scanner is joined by a physical camera kill switch, enabling users to manually cut the power to the webcam when it isn't being actively used. They're worthwhile additions that improve the package as a whole, making this a good purchase for anyone with a sticker over their current laptop webcam.

The battery life is impressive, too, powering the bright screen and excellent Bang & Olufsen audio for hours at a time. There are also two full-size USB-A ports here that unfold with little curved catches, a welcome sight on an ultralight laptop. There are a few other bonus features here, such as HP's own BIOS Recovery function, and it's all icing on top of an excellently baked cake. Were this a lesser product, we might say that the price is a tad high at $1,250, but compared to other notebooks, there's plenty here to make it worthwhile. **–CHRISTIAN GUYTON**

VERDICT 9 **HP Envy 13-aq0003na**

+ FOR THE WIN Solid performance for an ultralight; good security features; great battery life.

– DEADLY SIN Discrete GPU isn't very powerful; flimsy trackpad.

$1,250, http://store.hp.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	743	593 (-20%)
CrystalDisk QD32 Sequential Read (MB/s)	563	1,624 (188%)
CrystalDisk QD32 Sequential Write (MB/s)	133	854 (542%)
3DMark: Fire Strike (Index)	13,202	2,796 (-79%)
Rise of the Tomb Raider (fps)	99	16 (-84%)
PCMark 8 (Index)	2,376	3,400 (43%)
Battery Life: Movie Playback (Mins)	183	708 (287%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our laptop zero-point is the Asus GL502VS-DS71, with an Intel Core i7-7700HQ CPU, an 8GB GTX 1070, and 16GB of DDR4. All game tests are performed at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i7-8565U
Graphics	Nvidia GeForce MX250 2GB GDDR5
RAM	16GB DDR4-2400 SDRAM
Screen	13.3-inch 1080p 72% NTSC color gamut
Storage	1TB PCIe NVMe M.2 SSD
Keyboard	Full-size chiclet backlit
Battery	Four-cell 53Wh
PSU	65W AC adapter
Weight	2.6lb
OS	Windows 10 Home 64-bit

AORUS
AORUS
X570 AORUS MASTER

The tiny fan is hidden under that Aorus-branded grille.

Gigabyte X570 Aorus Master

Power over presentation

THE X570 AORUS MASTER isn't much to look at. Gigabyte has never been known for overly flashy motherboards, but the Aorus Master feels like it's reached a new level of function over form. With an almost brutalist black and gray design and barely any lighting—just a few LEDs around the rear I/O—this isn't a mobo for those trying to make their build look as bright and colorful as possible. Those LEDs are addressable, yes, but they're distinctly underwhelming in action.

Thankfully, appearance isn't an indicator of quality. The Aorus Master might look dull, but it functions well. Looking at the raw numbers, it pretty comfortably outperforms previous-generation X470 motherboards when equipped with a new 3000-series Ryzen CPU. The performance differences are small but notable, with the exception of SSD transfer speeds. With the staple PCIe 4.0 support that the X570 generation introduced, the Aorus Master has blisteringly fast M.2 transfer speeds, breaking 5,000MB/s in our tests. It's still immensely satisfying to see, even if it's a niche feature that has the potential to be bottlenecked by other parts of any given system.

Memory latency and processor-heavy tasks come out more or less the same as previous-generation boards, albeit with the Master coming out just ahead. The board doesn't allow for much overclocking potential, but that's more of a problem with the new Ryzen processors that has yet to be resolved by AMD. Even so, it's not hard to get our Ryzen 9 3900X running at a stable 4.2GHz, though sadly the Master needs the same voltage to achieve that as the X470 board we tested. It's a straightforward upgrade, and at $300, it won't sting your wallet too badly—though there are cheaper options available, from Gigabyte and others.

The improved performance comes at a cost, however. The Aorus Master guzzles power under load, demanding far more than the X470 board—disappointing when examined alongside the modest performance gains. Idle wattage isn't much higher, but if you like to overclock or have your system running demanding software for hours on end, this might not be the right motherboard for you. The reason for this increased power draw isn't clear; the dedicated fan and numerous temperature sensors could be the cause, although other X570 boards we've seen haven't had this problem.

In terms of physical design elements, rather than benchmarking performance, the Master starts to look a bit more appealing. It comes with three of those super-speedy NVMe Gen4 ports for M.2 SSDs, each with its own removable heat spreader. We'd love to force all the SSD and motherboard manufacturers to sit down together and discuss whether the heat management system needs to come on the board or on the drive itself, but we can't hold that against this motherboard.

In terms of connectivity, this board has all the usual trimmings. Wi-Fi support on the rear I/O was a welcome surprise (Gigabyte tends to stick "Wi-Fi" in the name of boards with their own antenna ports), and there's support for USB-C ports from the front I/O, joined by a USB-C port on the rear I/O. This rear port supports fast-charge for mobile devices, too; a minor addition for some, but a lifesaver for others. The board also has the increasingly common two-digit calculator-style display, handing you a hopefully-helpful error code in the event of a failure to boot. The tiny motherboard fan and clever thermal design do good work as well. The lack of an HDMI or DisplayPort connector precludes the use of integrated graphics, but that's not a dealbreaker, as anyone spending $300 on a mobo can afford a GPU to plug into it.

There's nothing important you'd miss if you threw this board into a generic system build. It's not exciting, but it is pretty good. Unless you're planning on upgrading your CPU and storage, it's an unnecessary replacement for an X470 or even X370 board, but if you're looking to build an entirely new system, you could definitely do worse than the Aorus Master. –**CHRISTIAN GUYTON**

BENCHMARKS

	Gigabyte X570 Aorus Master	Asus ROG Strix X470-F Gaming
Tech ARP's X264 (fps)	**62.57**	61.84
Cinebench R15 Multi (Index)	**3,106**	2,994
Fry Render (m:s)	**01:22**	01:32
AIDA64 Memory Latency (ns)	**76**	78
CrystalDisk QD32 Sequential Read (MB/s)	**5,013**	1,741
CrystalDisk QD32 Sequential Write (MB/s)	**4,271**	1,716
Power Draw Idle/Load (Watts)	65/206	**47/162**
Total War: Warhammer II (Avg fps)	**58**	**58**
Lowest Voltage @ 4.2GHz (Volts)	**1.17**	**1.17**
Maximum OC Achieved (GHz @ Volts)	**4.2 @ 1.17**	**4.2 @ 1.17**

Best scores are in bold. Our test bed consists of an AMD Ryzen 9 3900X, 32GB (4x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a 2TB Gigabyte Aorus M.2 SSD. All games were tested at 1440p on the highest graphical profile.

VERDICT
9

Gigabyte X570 Aorus Master

⊞ **MASTER** Very fast M.2 transfer speeds; generally solid performance; good thermal design.

⊟ **APPRENTICE** Heavy power draw; basic appearance; underwhelming lighting.

$360, http://gigabyte.com

SPECIFICATIONS

Chipset/Socket	X570/AM4
Form Factor	ATX
Memory Support	128GB @ 4,400MT/s
M.2/U.2 Support	3x M.2
SATA Support	6x SATA 6Gb/s
Max PCIe Support	3x PCIe 4.0 x16 (x8x8)
Rear I/O	2x USB 3.2 Gen1, 3x USB 3.2 Gen2, 5x USB 2.0, 1x USB 3.2 Type-C, Realtek 2.5 GbE, Intel Gigabit Ethernet, Wireless A/C, 5.1 audio out, optical audio out

Asus ProArt PA34V

Asus throws a curveball at content creators

A THOUSAND BUCKS is a bundle of cash for a PC monitor. It's the kind of budget that buys you a lot of choice. Everything from 4K resolutions and high refresh rates to true HDR visuals, massive panel sizes, and more are on the menu. At first glance, therefore, Asus's $1,000 ProArt PA34V looks pretty pedestrian. With a 34-inch curved panel, a mere 3440x1440 pixels, and 100Hz refresh, it's hardly poverty stricken when it comes to features, but can it justify that four-figure price tag?

It all comes down to remit. The ProArt is pitched at professional content creators. Given how expensive such screens can be, $1,000 doesn't seem so punchy. What's more, while a 34-inch curved 1440p 100Hz gaming panel isn't novel, it's unusual in the pro space. Asus hasn't spared the pennies from a design and engineering perspective either. The stand is beautifully machined and the screen enclosure feels expensive. It's all a clear cut above the usual consumer electronics fare.

The positive vibes continue when you fire the ProArt up. Seasoned eyes will recognize what is a very nicely calibrated IPS panel. Indeed, Asus provides a calibration report with each PA34V. Our review sample's report shows Delta Es below two across the board, with all but one entry below one. Nice.

While we're discussing technicalities, professionals will appreciate that the ProArt is good for 100 percent of the sRGB color space and also HDR-10. But that doesn't mean it's a true HDR display, due to its lack of local dimming and a maximum brightness of 300cd/m^2. However, what the HDR-10 compliance does ensure is 10-bit color depth and support for the Rec.2020 color space, which will be a target for some content creators. Among other relevant presets in the comprehensive OSD is the commonly used HDTV Rec.709 preset. Anyway, in our testing the ProArt is mostly a star performer, whether that's the smoothness of rendered gradients, its impeccable viewing angles, or the huge detail on offer in test white scales.

What the ProArt is not, is perfect. In calibration terms, a little compression is visible in black scales. That could be dialed out. More of a permanent problem is the relatively coarse pixel pitch and desktop space. For $1,000, you can choose from a wide range of 4K UHD monitors. Admittedly, you're not going to get a high-end pro 4K monitor for that kind of cash, but a prosumer 4K panel is well within reach, and that secures you much more screen real estate and sharper imagery.

What we'd really like to see at this price is something akin to the LG 34WK95U. That's also 34 inches and curved, but delivers a 5K2K pixel grid, enabling you to view full resolution 4K content with space left for menus, toolbars, and timelines. Of course, the 34WK95U clocks in at around $1,500, so it's a lot more expensive, but if you could stretch to the LG, it's worth the extra cash in return for dramatically improved visual ergonomics.

Even limited to $1,000, the PA34V is a slightly hard sell. The 100Hz refresh and adaptive sync support are nice for a bit of gaming on the side, but that's hardly a key priority for content creators. The USB Type-C input support is again welcome, especially for anyone who uses a laptop, but it's surely a given at this price point in 2019. Overall, the Asus ProArt PA34V is a very nice panel. As an all-arounder for price-insensitive buyers, it's seriously appealing. We're just not convinced it would secure $1,000 out of our content creation budget. **–JEREMY LAIRD**

VERDICT **8**

Asus ProArt PA34V

+ AHEAD OF THE CURVE Lovely IPS panel; nicely calibrated; fabulous build quality.

− BEHIND THE TIMES Limited resolution for content creation; not true HDR.

$999, www.asus.com

SPECIFICATIONS

Panel Size	34-inch
Panel Type	IPS
Resolution	3440x1440
Pixel Pitch	109 ppi
Brightness	300cd/m^2
Contrast	1,000:1
Response	5ms
VESA Mount	100 x 100mm
Warranty	Three years

Asus's pricey new ProArt brings curved panel tech to the pro monitor market.

Gigabyte Aorus Gen4 2TB

This PCIe 4.0 SSD is seriously hot stuff…

WIND THE CLOCK way back to 1981 and the first IBM PC, the 5150. Take a peek inside and you'd see a motherboard full of chips. But not one of them, including the CPU, had a heatsink, much less active cooling.

Fast-forward nearly 40 years, and a big, fat fan is the bare minimum for a modern PC processor, and liquid cooling is almost the norm for performance CPUs. Graphics cards have followed a similar path from minimal to monumental cooling solutions. The GeForce 256 had a cute little fan; the latest GPUs require monster leaf blowers to keep cool. With the arrival of the new Gigabyte Aorus Gen4 SSD, we're beginning to wonder whether solid-state storage could—or, perhaps more pertinently, should—head the same way.

The Aorus is notable for its double-sided copper heat spreader, which lowers temperatures by 16 percent. The question is whether this improves performance. After all, do SSDs actually run that hot?

We have answers for you, but first let's cover off the Aorus's speeds and feeds. It's the second SSD we've seen with support for the latest 4.0 specification of the PCI Express interface, the first being the Corsair MP600. It probably shouldn't come as a surprise that both drives feature the Phison PS5016-E16 controller chipset, given it's one of the first to support PCIe 4.0.

For the record, the Phison PS5016-E16 features eight NAND channels, DDR4 DRAM caching, four PCIe 4.0 links, and the NVMe protocol in 1.3 spec, so it's bang up to date. Paired with TLC NAND flash memory and 2GB of cache memory, the upshot, for this 2TB model of the Aorus range at least, includes sequential read performance of 5GB/s, writes of 4.4GB/s, and IOPS around the 750,000 mark.

These are, we need hardly point out, very big numbers indeed, even if they do leave a fair bit on the table in terms of the peak theoretical bandwidth available from a quad-link PCIe 4.0 interface. The question is how all that translates into real-world performance. The answer involves the aforementioned thermal properties we alluded to at the outset.

Throw a large sustained workload at the Auros and it starts out crazy fast, but eventually slows to what you might characterize as SATA speeds. In our testing, it took around 300GB of sustained writes before the drive dropped from performance measured in GB/s down to around 400–600MB/s. At which point it was very, very hot to the touch.

Long story short, we believe the Auros thermal throttles under such workloads, even with the copper heat spreader. The same is true of the Corsair offering, but that was a significantly smaller drive. Point being, if it takes nearly half the drive's capacity to throttle, that's easier to tolerate. Indeed, a 250GB drive based on this technology would probably fill up before it throttled. With 2TB on offer here, you're arguably more likely to actually run up against this limitation.

Anyway, elsewhere, the Auros largely performs extremely well, its numbers very much in line with the Corsair MP600, except for our internal file copy test, which was disappointing for reasons we do not fully comprehend. In any case, it still qualifies as a very, very fast NAND drive. Intel's Optane drives maintain the crown in terms of 4K random access performance, of course, but these new PCIe 4.0 NAND drives aren't too shabby for 4K, either.

All the same, the throttling issues thrown up by the Auros do make us ponder whether we are likely to see active-cooled SSDs sometime soon. If this drive is anything to go by, active cooling may be necessary to sustainably make the most of the huge bandwidth on offer from PCI Express 4.0. If this Auros is overheating at 5GB/s, hitting 8GB/s could send solid-state drives into serious meltdown. **–JEREMY LAIRD**

BENCHMARKS

	Gigabyte Aorus 2TB	Corsair MP600 1TB	Intel 905p 512GB
30GB Internal Copy (Seconds)	37	**22**	29
CrystalDisk 6 Sequential Read/Write (MB/s)	**4,906**/4,270	4,867/**4,289**	2,632/2,313
Anvil 4K QD 1 Read/Write (MB/s)	53/**181**	54/174	**131**/145
Anvil 4K QD 2 Read/Write (MB/s)	112/**336**	111/232	**245**/273
Anvil 4K QD 4 Read/Write (MB/s)	214/**660**	215/604	**468**/518

Best scores are in bold. Our test bench consists of an AMD Ryzen 9 3900X, a Gigabyte X570 Aorus Master, an Nvidia GeForce GTX 1080, 32GB of Corsair Vengeance RGB Pro DDR4, and a Corsair Neutron 240GB OS SSD.

VERDICT

8

Gigabyte Aorus Gen4 2TB

+ STAR TREK TNG Huge peak performance; very strong feature set.

− STARK TREK Performance eventually throttles; there's a number of performance inconsistencies.

$459, www.aorus.com

SPECIFICATIONS

Form Factor	M.2 (2280)
Capacity	2TB
Memory Type	3D TLC
Interface	PCIe 4.0 x4
Control Protocol	NVMe 1.3
Reads/Writes	5GB/s and 4.4GB/s
Read/Write IOPS	750K/700K
Warranty	Five years or 3,600TBW

Is the Aorus Gen4's copper heat spreader just a stepping stone to active SSD cooling?

Zadak Spark RGB 16GB DDR4 4,133MHz

Gotta go fast

ZADAK IS AN ODDITY when it comes to PC component manufacturers. Formed from a group of computer hardware modders in 2015, the company initially set about selling high-end custom water-cooled systems, eventually making the leap to producing its own components. While its selection may be limited, everything is assured to be high-quality gear that Zadak's own master modders would use.

Enter the Spark RGB, Zadak's newest memory module, available in up to 64GB kits at a monstrous 4,133MHz—we've got a two-stick 16GB kit in for review. The design's highly stylized, silvery aluminum accents are evocative of an ancient warrior's helmet, while the jewel-shaped cutouts are soft transparent plastic that illuminates in an understated but attractive RGB effect when slotted into a motherboard. This lighting is compatible with all the big players' RGB software; Asus Aura Sync, MSI Mystic Light, Razer Chroma, and more.

Sadly, getting 4,133MHz memory up and running at the proper speed can be a nightmare, and sure enough, our initial setup wasn't compatible. A switch from AMD to Intel looked promising, but led to more meddling in the BIOS. The potential for any system to choke here is a risk to bear in mind, as many CPUs and motherboards refuse to play ball when it comes to higher operating frequencies. Mercifully, a bit of tinkering with the XMP profiles put us back on track.

With the Spark RGB running at full speed, we were pleased to see that it isn't all sizzle, no steak. Memory bandwidth and latency tests put it comfortably ahead of many 16GB kits, with comparable performance in other areas. Zadak lives up to its promise of high-end hardware aimed at enthusiasts; this is RAM for the discerning system builder, looking to maximize performance. Memory latency in particular is impressive, given that the Spark RGB has a CAS latency of 19; higher than the vast majority of memory that we tend to use and review here. Yet the tested latency of the Spark RGB beat out both of our comparison kits, which have CAS latencies of 14 and 16.

The only real downside is the price. Those familiar with Zadak will be aware of the premium one pays for its hardware, and the Spark RGB is no exception. At an eye-watering $280, this isn't a purchase for the faint of heart—although Zadak does offer a limited lifetime warranty, which assuages our wounded wallets slightly. When looking for alternatives, though, recognizable brands such as G.Skill and Patriot sell comparable 4,133MHz kits for significantly less, hurting Zadak's position.

In terms of raw quality, the Spark RGB is extremely good. The only thing holding it back from our coveted "Kick-Ass" award is the price. Looking at performance and visual design, the Spark RGB is awesome. It looks brilliant in almost any setup, the RGB lighting effects subtle enough not to distract, but vibrant enough to impress. The performance in some areas (zipping/unzipping files, or frame rates in games) isn't much improved over slower memory, although the latency and bandwidth improvements are enough to recommend this kit. There's also a lot of potential for overclockers, either by pumping up the operating frequency or running the memory at lower timings, both of which are possible for the experienced tweaker. **–CHRISTIAN GUYTON**

BENCHMARKS

	Zadak Spark RGB 16GB 4,133MHz C19	G.Skill Flare X 16GB 3,200MHz C14	Ballistix Elite 16GB 3,600MHz C16
SiSoft Sandra Memory Bandwidth (GB/s)	**35.4**	29.5	32.2
SiSoft Sandra Memory Latency (Nanoseconds)	**17.7**	19.3	19
Cinebench R15 (Index)	1,925	**1,996**	1,884
Rise of the Tomb Raider (fps)	**137**	**137**	**137**
FryBench (Time to Complete m:s)	**01:47**	01:49	01:50
25GB 7-Zip (Compression/Decompression Time m:s)	**13:08/02:35**	13:35/02:36	13:34/02:37
Price Per Gigabyte (US Dollars)	17.50	**8.43**	9.38

Best scores are in bold. Our test bench consists of an Intel Core i9-9900K, an Asus Maximus XI Gene, an Nvidia Geforce GTX 1080, and a Samsung 850 Evo 250GB SSD.

VERDICT 9

Zadak Spark RGB 16GB DDR4 4,133MHz C19

➕ **FIRESTARTER** Superfast; great appearance; overclocking potential

➖ **FLINTSTONE** Costly; minor performance gains in some areas.

$280, www.zadak.biz

SPECIFICATIONS

Capacity	16GB (2x 8GB)
Speed	4,133MT/s
Latency	19-21-21-42
Memory Type	DDR4
Voltage	1.4V

Western Digital MyCloud Home Duo 8TB

Backing up beautifully

NAS BOXES ARE NOTHING NEW to us, and if you're a seasoned system builder, there's a reasonable chance you've assembled one yourself at some point. For the uninitiated, NAS stands for network-attached storage. Essentially, a NAS allows for file storage across a network by a group of permitted users. A NAS system is simply a basic PC that makes those drives accessible, usually with just a rudimentary operating system and an Internet connection. In practice, they can work like a personal cloud, enabling you to wirelessly back up your files to a separate machine that functions like your own little server slice.

Of course, what we're describing here is a home-made NAS box. If you prefer the easy life (no meddling around inside the guts of a half-finished system), there are plenty of pre-built NAS systems out there, many of which are simpler and easier to use than a custom-made machine. Western Digital's MyCloud Home is one such example, aimed at families and working professionals who want a straightforward data storage solution. It couldn't be easier to use, either—just plug in the power and Ethernet cables, and this little white and silver cuboid is ready to go.

Accessing the drive (or drives, in this case; our Home Duo comes with two 4TB hard drives concealed inside) is a quick and convenient process, too. On a computer, it's as simple as accessing the MyCloud website via your browser of choice, which then functions not dissimilarly to Dropbox or Google Drive—just drag and drop your files there, and they're automatically saved. Alternatively, you can set up the desktop app's sync mode, which backs up all the files on a home or work computer automatically. For mobile devices, WD provides an Android/iOS app from where backups (and the MyCloud's on-drive storage) can be managed.

The mobile app is easy to use, and the browser version should be instantly familiar to anyone who's used cloud-based storage before. So, the attached software is solid; on to the hardware. The MyCloud Duo 8TB has, as the name suggests, two separate 4TB drives. In its default state, though, there is actually only 4TB of usable storage space (3.51TB after the preloaded software, if you want to be nitpicky). This is because the two drives are set to Mirror Mode using RAID 1, which produces a duplicate of your files on the mirrored drive. While this is a pretty solid fail-safe feature, it does effectively halve the amount of available storage space. Fortunately, you can choose to configure the drives using JBOD for the full 8TB, although paying $400 for 8TB of HDD storage is still somewhat galling, and if the device fails, you've lost your data.

DRIVE'S LICENSE

There is potential to upgrade, though; the drives inside are two standard Western Digital HDDs, and as such, the top can be removed, and they can be replaced with any compatible drives. If you're looking to upscale in the future, this could be a decent feature, although the initial price is still a tad high. With a standard Gigabit Ethernet connector, your Internet speed is theoretically the boundary to transfer speeds before the older HDD connector format gets in the way. However, in our internal tests, we saw speeds of around 40MB/s across a local connection; an unimpressive figure, to say the least. Transfer speed isn't really a concern if you're looking to use this as a wireless backup for your data, to be fair; the desktop sync function runs in the background, and because file duplication happens in the box rather than on your system, Mirror Mode has no impact on your day-to-day PC use.

The key downside when compared to a home-brew NAS machine is the lack of true customizability. The Home Duo functions more like an external hard drive with some nifty wireless access functions, thanks to the MyCloud app, rather than the superior functionality of proper NAS systems. There's no processor, no RAM, no OS. While the desktop app does allow for standard access through the Windows File Explorer, the whole process sits within the confines of WD's own access software. That's not inherently a problem, but it could be frustrating for seasoned tech heads who want to tweak their hardware more. If you're just looking for a simple but effective storage solution, though, this isn't bad. **–CHRISTIAN GUYTON**

VERDICT
7

Western Digital MyCloud Home Duo 8TB

BACK UP App functions well; potential for upgrades; easy setup.

SLACK OFF Relatively expensive; lack of expanded functionality; unexciting transfer rates.

$400, www.westerndigital.com

SPECIFICATIONS

Interface	Ethernet
Capacity	8TB (3.51TB default)
Dimensions	6.3 x 4 x 7 inches
Weight	5.3lb
Warranty	Two years

Corsair HS35

Affordable cans with surprisingly little compromise

THERE'S ALWAYS SOMETHING. When you dip down below $50 in the headset market, you know you're going to be making compromises somewhere. Perhaps it'll be comfort, or sound quality, or features and functionality—there's always something. The trick for manufacturers operating at this price point is effectively disguising what that something is, so that when it eventually reveals itself, you don't mind that much.

So it goes with Corsair's new HS35 headset, which takes a lot of design cues from the company's HS50 and HS70 cans, but keeps the outlay under $50. And it just happens that this one's especially good at playing down the inevitable compromises the pricing requires.

Starting with build quality, well sure, it's not encrusted with precious gemstones or elaborate RGB lighting arrays—and it's all the better for it. A mix of smart, understated black construction materials and finishes creates an overall look that speaks of a more expensive product, and while beauty is in the eye of the headset holder, we actually prefer this combo of matte and gloss plastic to the mesh finishes on the HS50 and HS70.

Rather than straying into the more experimental headband designs of Audio-Technica or SteelSeries, this HS35 is built around a lightweight aluminum band and padded with more than enough memory foam to keep the top of your head comfortable over longer sessions. There are memory foam pads around the earcups, too, but these feel less generous and—if you'll excuse the parlance—squidgy than the headband. That's not a big deal for the vast majority of users, but if you have bigger ears, you might find the chamber's slightly too shallow for you, and may experience some rubbing on the antihelix of your ear. And you thought the kids in the schoolyard calling you Dumbo was the worst of it.

Tipping the scales at 8.8oz, this is among the lightest headsets on the market at the moment, so comfort shouldn't be an issue on all but the very biggest or most unusually shaped heads. Certainly, it remained barely noticeable on this tester's cranium for three-hour stints at a time, and that's a big one for the plus column. A 3.5mm cable connects the HS35 to your PC, which means there's no scope for tinkering within Corsair's useful and largely unobtrusive CUE software. We can live without that at this price, but it's something to note if you're used to creating custom EQ profiles or switching between presets depending on whether you're gaming or listening to your favorite drill remixes of classic kids' TV themes.

And that leads us on to sound quality, which brings a lot of bass to the party, thanks to those 50mm drivers, but ultimately compromises on overall clarity and warmth as a result. This isn't a massive deal, and shouldn't be taken to mean that games and those aforementioned drill bangers don't still sound great when they're being fed through the HS35. What it does mean is there's a slightly artificial sound to these cans that's more pronounced as you raise the volume, a bit like the digital "ring" you get from DTS: Headphone X in digital surround-compatible headsets.

So, that's the HS35's "something." Is it a massive deal? That depends on your personal leanings. For audiophiles looking to build a rig on a tight budget, the loose bass and lack of clarity will grate a little over time. For everyone else just looking to game in comfort for longer sessions without looking like a flyover shot of Atlantic City at night, this is a great pick. We're seriously impressed with the build quality for the price, and wearing a headset you can forget is even on your head is a boon you'd pay three times this price for after a few hours wearing an uncomfortable model. **–PHIL IWANIUK**

VERDICT 7

Corsair HS35

➕ **SMOOTH SAILING** Great construction quality; lightweight design.

➖ **CHOPPY WATERS** Bass affects clarity; no software tweaking.

$40, www.corsair.com

SPECIFICATIONS

Driver Type	50mm neodymium
Frequency Response	20Hz–20KHz
Design Style	Closed back
Microphone Type	Unidirectional noise-canceling
Weight	8.8oz
Connectivity	3.5mm
Cord Length	6ft

Asus ROG Strix Carry

Boy, you've gotta carry that mouse, carry that mouse a long time

DOES EVERY game-leaning peripheral absolutely require big flashing lights or a design that makes it look as though the ghost of H.R. Giger has returned to Earth and had a manic episode at the plastic factory? We are here to tell you it does not. For all that we love a beautiful desk, function is the strongest attribute any peripheral can have. If it does its job magnificently, that's what is going to win us over.

Which brings us to the Asus ROG Strix Carry, a gaming peripheral that indeed bucks the trend. There are no lights. There's really nothing in the way of glitz, outwardly, and indeed no room for it, because Asus has carved away just about all it can in pursuit of creating a portable wireless gaming mouse. And we like that: This doesn't look out of place on any desk, it's (technically) pocketable, if you don't mind a mouse-shaped bulge in your pants (or you could use the included pouch, like a sensible person), yet Asus has kept itself calm enough to avoid cutting the size down beyond the point of usability. Sure, if you've been mousing wrong for so long that your right hand has contorted into such a shape that you can only push a mouse around with the heel of your palm, then perhaps you'll struggle, but for fingertip (or tentatively claw) control, this does just fine. After a few days as our primary mouse, we barely even noticed it was a compact design at all.

The whole of the Strix Carry's top shell can be separated from its magnetic clutch to reveal its guts, which comprise a pair of AA batteries (no Li-on cells here), a teeny USB wireless module nestled in a handy internal slot, and a pair of Omron switches for its main two buttons. These are socketed rather than being soldered in, and there's a replacement pair in the package (along with the requisite removal tool) should you wish to try out a different feel, or if you somehow click so frequently that you exceed their rated 50 million presses.

There's good grippy silicon on both sides, although, even at this small size, the shell has been molded in such a way that it's a distinctly right-handed mouse, with a pair of very thin and just adequate thumb buttons joining an excellent rubber-topped notched wheel in rounding out the control options. The tried-and-true Pixart sensor, in these crazy times, has half the sensitivity of the sensors in top-end gaming mice, but going beyond its 7,200 cpi would be overkill for all but the most twitch-wristed gamer. It coped perfectly well with all of our surface tests—this is a precision mouse.

CONNECTIVE ISSUES

In terms of connectivity, while there's no wired backup on offer, you can opt, via a base-mounted switch, for either Bluetooth or Asus's 2.4GHz wireless, which offers 1ms polling times at the cost of a slight hit in battery life. 1ms seems to be the new standard for peripherals, and when it works, it's wonderful—but when we ran the USB module next to another similar dongle (using Corsair's similarly fast 2.4GHz Slipstream technology), the input of the Strix Carry transformed into an unusably glitchy mess. Whether that was the fault of one module or another, it's certainly something to be wary of—Bluetooth solved the problem, but Bluetooth is really a secondary mode here. If you're using it as your primary communication method, you're doing it wrong.

So, this has its potential issues. And while all component boxes are checked nicely, and it certainly functions well outside of those issues, we do also need to wheel around on ourselves and get contradictory: The ROG Strix Carry is probably the most boring device ever to land in the ROG line. That's a blessing, but it's also a curse—this is a good mouse, but we can't bring ourselves to get excited about it. **–ALEX COX**

VERDICT 8

Asus ROG Strix Carry

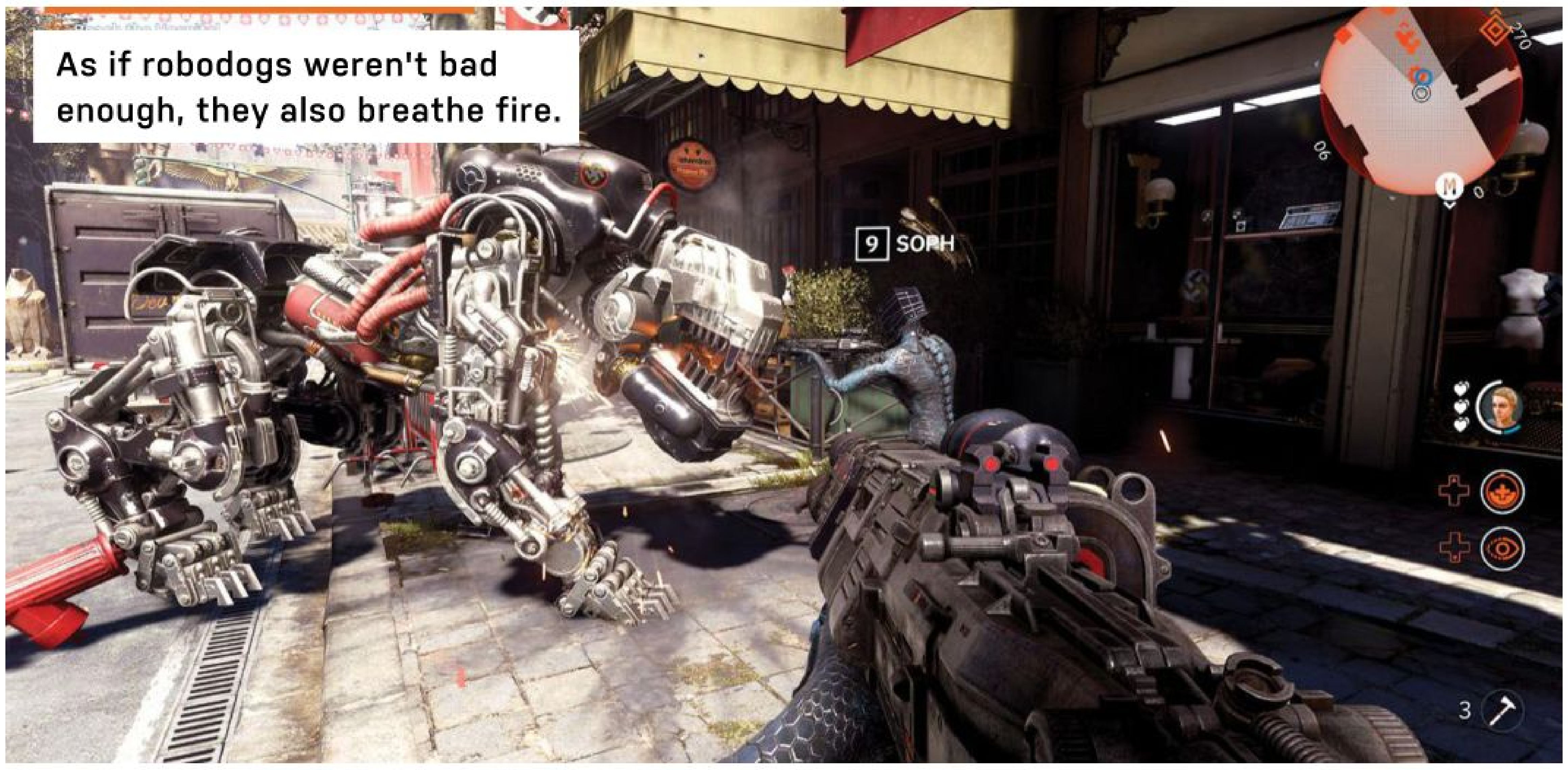
⊞ **PORTABLE** Small and entirely usable; discrete design; 1ms wireless.

⊟ **DEPLORABLE** Wireless can be glitchy; reasonably dull; expensive.

$75, www.asus.com

SPECIFICATIONS

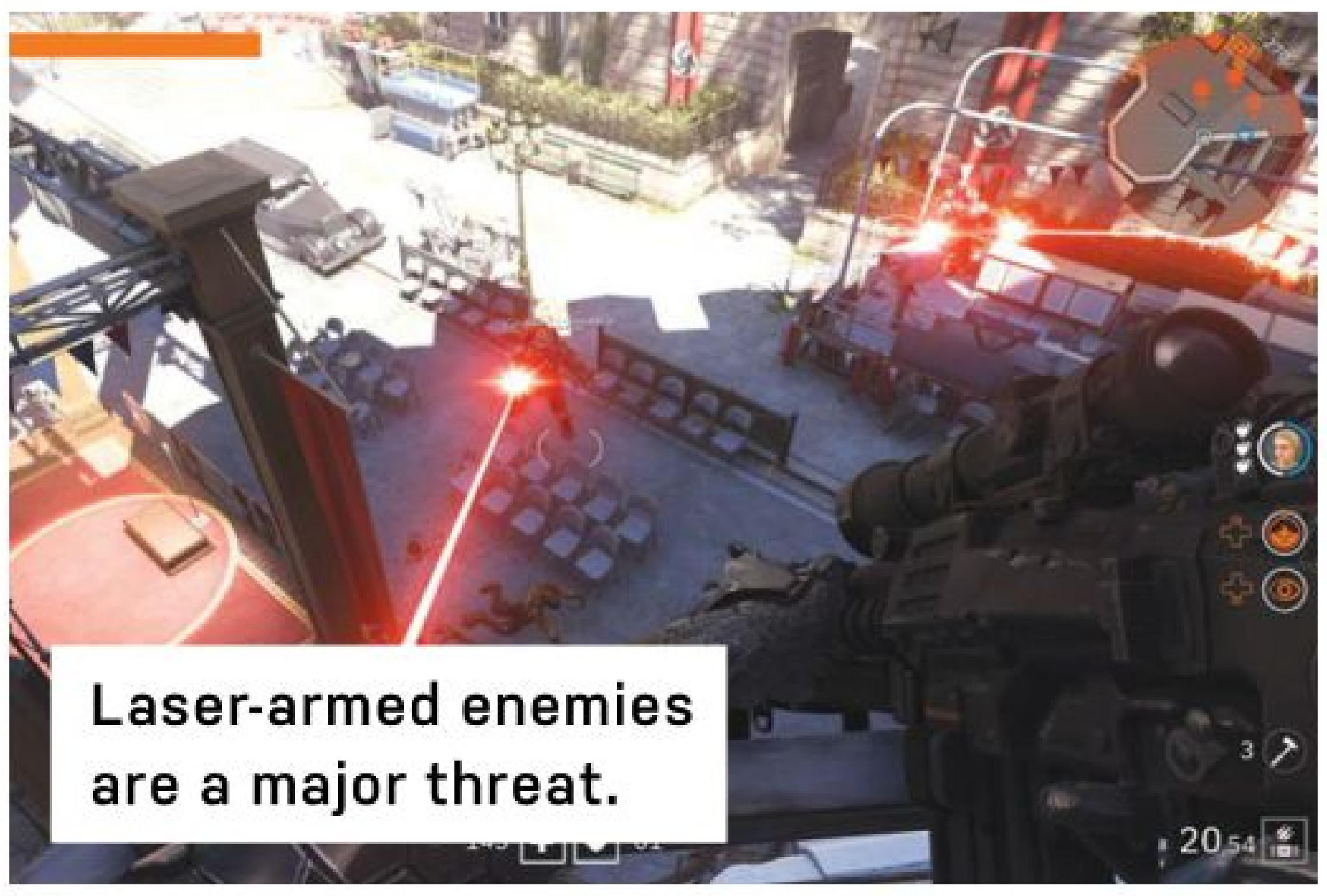
Sensor	Optical
Sensitivity	7,200 cpi
Sensor Model	Pixart PMW3330
Polling Rate	1,000Hz
Programmable Buttons	Yes
LEDs	One (sensitivity)
Cable Length	None
Weight	2.6oz (without batteries)



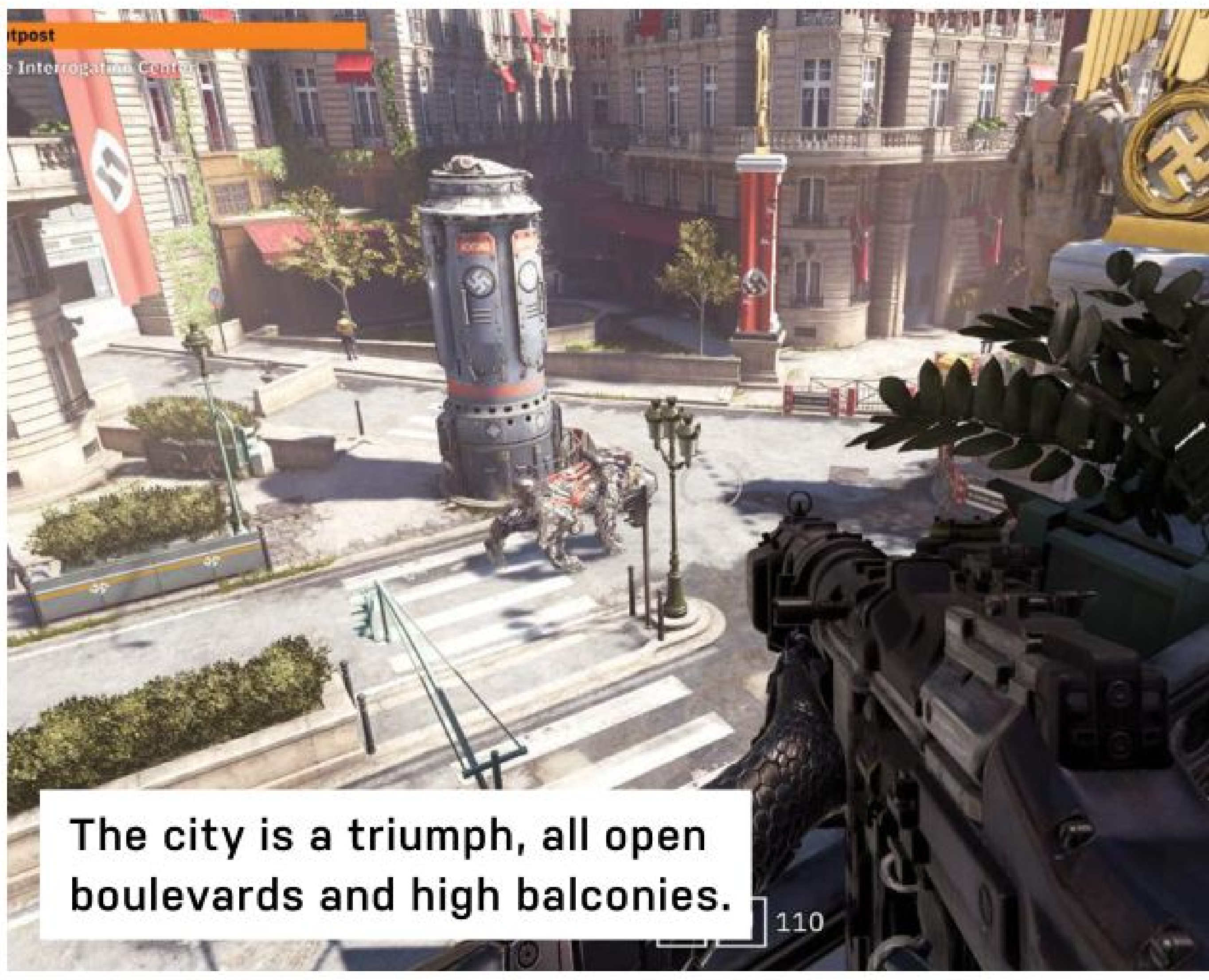
As if robodogs weren't bad enough, they also breathe fire.

Sneaking around is possible, but blasting is more fun.

The third member of your gang, Abby, provides radio support.



Laser-armed enemies are a major threat.



The city is a triumph, all open boulevards and high balconies.

Wolfenstein: Youngblood

Two is better than one when killing bad dudes

PARIS, 1980, in the retrofuturistic New Order timeline. The Nazis still rule Europe through their usual mixture of massive lasers, cybernetically enhanced supersoldiers, and dogs wearing suicide vests, but the Resistance fights on and Terror Billy is still alive. He's thriving, in fact, having produced two daughters.

In *Wolfenstein II,* there's a section in which a character gains a new lease of life, and some sweet combat moves, from a super-suit built from ancient technology "Why aren't we playing that game?" we asked, as she kicks Nazis through windows. *Youngblood* looks like it could be that game, as our super-suited co-op protagonists are young, exuberant, call each other "dude," and have some excellent eye makeup. They also hang out with their nerdy friend who makes super-suits in her bedroom, making early scenes look like some sort of *Stranger Things* with massive shotguns. Note to devs: this would be awesome. The game boils down to sisters against brothers, the latter being three defensive towers containing Nazi supercomputer technology. Faced with a furious twin-pronged assault, the Nazis have leveled up. Literally.

Call it Arkane's influence if you like, but enemies now come with levels, health bars, and armor points. This means a high-level shotgun trooper can take a huge amount of punishment before going down, but has the benefit of pointing out when you've gone in over your head.

Stealth should help you get in and out of an objective unmolested, but thanks to the level system, a silenced headshot on an unaware bad guy doesn't guarantee a kill. Instead, it just draws an entire army to your position.

Side missions allow you to level up yourselves, buying add-ons for your guns with silver coins, and increasing their damage, accuracy, and fire rate. You can also unlock new combat moves, although it's galling to see things like the use of heavy weapons scavenged from supersoldiers gated behind an unlock.

Arkane's input can be felt most strongly in the design of the city streets. Missions take you back to the same areas multiple times, and there is a warren of alleys and passageways in which to lose the Nazi pursuit. Balconies, tempting open windows, and sunshades bring verticality into play, helped by a double-jump unlocked from the start. Exploring these places turns up a steady supply of silver coins, diary entries, and encrypted computer discs that provide story cues. The Nazis of the 1980s are big on computers.

The game is of the high quality you'd expect from its co-op developers. Creepy racks of deactivated robots twitch as you approach, Nazi commanders call in reinforcements unless you kill them first, and once a mission is complete, there's a fast travel way to return to the hub without having to fight your way back.

Youngblood isn't what we expected from a *Wolfenstein* sequel—more of the single-player same was a better bet—but the twins tear it up across Paris in a highly satisfying way. Like all co-op games, it's best with a friend, but not even some poor friendly AI can take the fun out of spattering techno-Nazis. **–IAN EVENDEN**

VERDICT 8

Wolfenstein: Youngblood

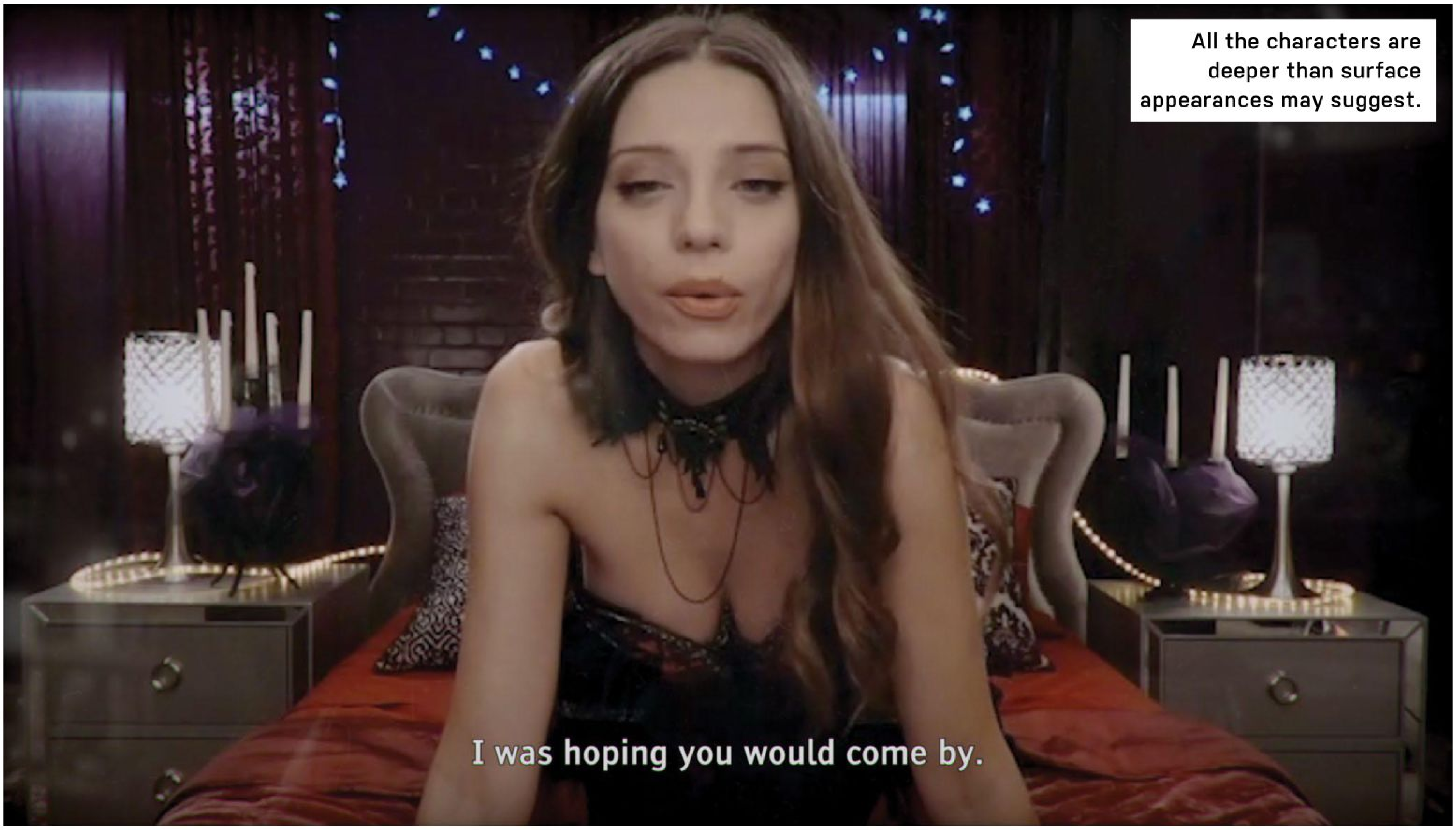
+ TWINS Blood sprays and bloody chunks; rotary shotguns; what's not to like?

- SPINS Pointless stealth; level-gated areas; new experience system may rankle.

RECOMMENDED SPECS Ryzen 5 1600X/ Core i7-4770; 16GB RAM; GTX 1060 6GB or AMD equivalent.

$30, http://bethesda.net, ESRB: M

© BETHESDA



All the characters are deeper than surface appearances may suggest.

© ANNA PURNA INTERACTIVE

Telling Lies

Our dog has six legs. Seriously. We wouldn't lie

WE NEVER THOUGHT we'd live long enough to see the return of FMV, yet here we are: Four years after *Her Story*, with a whole new set of tapes to scrub through.

If you haven't played *Her Story*, why not? The game will run on the creakiest of platforms—check out the recommended specs for this one and you'll get the idea—and was very warmly received. *Telling Lies* is more of the same from director Sam Barlow, but bigger in every regard.

You piece together a narrative from tapes that have come into your possession. They've been fully indexed and subtitled, so you can search for whatever word comes into your head—the only limit is that you're restricted to the first five hits from the search engine. Clicking on a clip drops you in at the moment the search term is spoken, so you have to rewind to the beginning to see the whole thing. Videos are one-sided conversations with the responses missing, so you need to cleverly search out the other side if you want to know the whole story.

Videos play full-screen, and between searches and playback you're faced with a bland computer desktop in the Ubuntu mold. There's a notepad app, Solitaire, a trashcan, and some garbled instructions. There's no doubt you're a voyeur. Your reflection moves and reacts in the computer screen as you watch—and the game isn't above pulling tricks with this.

At first, you can feel a little lost. As the game commences, your character walks up some stairs, sits down, starts the computer, then searches for "love." That's it. There's no sign of her motivation, why that word in particular, or how these jumbled conversation snippets came to be so important to her. Watch the "love" clips, however, and you start to notice something awry. We'll say no more—we can't. Everything is a potential spoiler.

The cast is recognizable, from *Prometheus* to *Westworld* to *X-Men*. They look straight into the camera and talk at you, their conversations often intimate. You may begin to wonder how you'd reply in the silences where the other side should be. One character is a little girl, and she takes you into her blanket fort as she speaks to her father. Another is a sex worker, but her conversations have far less to do with sex than her costumes do. There's plenty here to make you turn away, to check you're not being watched as you do the watching. It's all beautifully judged and spotlessly performed.

The software you use to play the videos is well designed, too. Clips can be bookmarked, and words selected from subtitles can be turned into new search terms. Working with so many clips from multiple sources over two years of in-game time is made smooth and effortless.

If you're not actively chasing down a lead, but are casting a net in the hope of picking one up, the game can feel aimless. When you're noting down new search terms from every video—we found a real-world notepad to be of more use than the in-game app—and watching each deduction pay off, it's thrilling.

Barlow has invented a new kind of game here. While *Her Story's* single actress and camera was a wobbly baby step, this is a confident stride across a new frontier. We cannot wait to see where it takes us next. –**IAN EVENDEN**

VERDICT **9**

Telling Lies

+ TRUTH Compelling; disturbing; thrilling; personal.

− LIES Too many pink unicorns; shotgun sound effects too loud.

RECOMMENDED SPECS Any dual-core CPU; 2GB RAM; GeForce 8800 or equivalent.

$20, http://annapurna.pictures, ESRB: Not rated

LAB NOTES

JARRED WALTON, SENIOR EDITOR

The Control Ray Tracing Needs

Is the promise of a realistically rendered future finally delivering?

ONE YEAR AFTER Nvidia announced real-time ray tracing as the Next Big Thing™, we're finally starting to see the tech put to good use. We've had *Battlefield 5's* ray-traced reflections, *Metro Exodus's* ray-traced global illumination, and *Shadow of the Tomb Raider's* ray-traced shadows. *Control* ups the ante by including ray-traced reflections, transparent reflections, diffuse lighting, and contact shadows.

Of the ray-traced effects, the reflections and transparent reflections are the most noticeable. Thanks to the indoor office environments of The Oldest House, there are plenty of shiny surfaces and partially reflective windows. The contrast between ray-traced and traditional rendering can be massive. Once you've seen the glorious ray-traced goodness, it's hard to go back. Naturally, there's still a performance hit. The "medium" ray-tracing option (just reflections and transparent reflections) knocks frame rates down 25–35 percent. Maxing out image fidelity, meanwhile, cuts performance nearly in half.

There's hope in the form of DLSS, which renders at a lower resolution, then uses an AI trained network to upscale and antialias the result. *Control* supports DLSS at all resolutions and all cards, with a higher and lower rendering resolution. At 1080p, DLSS can render at either 1280x720 or 960x540 before upscaling, and the lower rendering resolution substantially improves performance—it's actually faster with DLSS and ray-traced reflections than at native without ray tracing.

In motion, DLSS also looks pretty good. If you look carefully, you can spot the difference between native and DLSS, but in motion, it's far more difficult. And that's a good thing, because it will probably take another hardware refresh or two from Nvidia before we can max out all the ray-traced settings in *Control* at 1440p and still get 60fps. I can't wait for the RTX 3080 Ti!

***Control* is the best implementation of ray-tracing effects we've seen in a game.**

JOANNA NELIUS

Hardware Staff Writer

It was a real blast from the past reviewing a desktop PC with an optical drive (see Velocity Micro Raptor Z55 review, pg. 76). While they don't serve much of a purpose anymore, it did make me think about some of the '90s games I still have on CD. *SimCoaster, 3D Ultra Minigolf, Prison Tycoon 2 Maximum Security*—I have a lot of fond memories of those games. Steam has a great feature that allows you to add games to your library with the original product key, but since I ditched the optical drive when I built my recent rig, I don't have a way to play them, unless I want to spring for an external drive. They may be almost obsolete, but they're a good archival tool.

ALAN DEXTER

Executive Editor

A few months ago, I stated I had no interest in playing *WoW Classic*. What I wasn't prepared for was the coverage that the launch would garner, as an army of Twitch streamers pushed to get world firsts. It quickly became the biggest game on Twitch—Method's hopes of repeating its success in the current game may have been dashed, but the production still made for some great viewing. I managed to hold off resubbing, partly because I know how much of a time sink the game is, but also due to the ludicrously long queues. A three-hour queue is not my idea of fun. Additional servers have resolved this, though, which means I'm running out of reasons to avoid it.

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Editors' Picks: Digital Discoveries

Hardware lead, Bo Moore, and staff writer, Christian Guyton, take a few minutes to catch some R&R

NINTENDO SWITCH LITE

I love PC games, but I've found my favorite place to play them is often not on PC. Don't get me wrong, I'll never play a shooter like *Apex Legends* or an MMO like *Final Fantasy XIV* on console—the PC will always be their home for me. But for small indie titles, I play them most of the time on Switch. *Hollow Knight, Slay the Spire, Into the Breach*—some of the best PC games of the last few years, I played on my Switch. Specifically, the Switch in handheld mode.

As of September, there's a new Switch on the block: the Switch Lite. It's a bit smaller, costs $100 less than its predecessor, and comes in some sweet colors. It also can't "switch" between handheld and console mode. The side controllers don't slide off, and you can't pop it into a docking station to connect to your TV. In other words, it's handheld only. But that's no problem for me. I'm never going to play *Overwatch* on the Switch, even though Blizzard recently announced it's headed for the console. Honestly, I can't remember the last time I docked the Switch to play on TV. No, to me it's the perfect handheld console. Handheld-only in exchange for rad colors and a cheaper price? Sign me up.

$199, www.nintendo.com/switch/lite/

NINTENDO SWITCH

© NINTENDO, MEGACRIT

SLAY THE SPIRE

On release, this card-based roguelike passed me by, and was sitting in my Steam library untouched for months before I decided to give it a shot a few weeks back. What a mistake I made in leaving it alone; *Slay the Spire* is a brilliant, wacky, turn-based game about scaling a gigantic tower in hope of striking down the beating heart at its peak, and I love it.

You make your way through a series of battles, random encounters, and puzzles, with the aim of defeating three hulking bosses. Cards fall into three categories: attacks, utility cards, and cards that add to your block stat. Block reduces enemy damage and dissipates at the start of your turn, forcing you to constantly manage it.

Most interestingly, you can see your opponents' intentions before playing your cards, enabling you to strategize by preparing to block an attack or take advantage of an opening. Cards are added to your deck regularly, resulting in some hilariously overpowered builds, and taking full advantage of this is a must, due to the often punishing difficulty. Consecutive runs unlock new cards and items for future ventures, creating a compelling gameplay loop. I've been having a blast.

$25, www.megacrit.com

GEEK TESTED & APPROVED

DATASHUR PRO²

DatAshur Pro 2 128GB

DIGITAL SECURITY is one thing, but hardware security is quite another. The best antivirus software in the world won't do jack if some hooligan runs off with your laptop, filled to the brim with important work files, passwords, and, uh, personal pictures. We're not one to judge, and neither is iStorage. The DatAshur Pro 2, the latest in its line of encrypted flash drives, promises to keep your data secure, even if some nude-leaking monster snags it.

This drive passes a NATO-standard tamper-proof design compliance test, so trying to break into the drive renders the contents unusable and provides evidence of tampering. On the digital side, it requires a 7 to 15-digit PIN to access, and is compatible with almost all devices with a USB port. The PIN makes it ideal for personal use, but it's possible to create user and admin PINs, too, ideal for use in a business setting. It also comes formatted for using a directly bootable OS; plug it in and go.

The Pro 2 comes with an on-board crypto-chip, providing military-grade real-time encryption, and a microprocessor equipped to rebuff common hacking attacks, such as SPA and DEMA. The PIN system also protects against brute force attempts by locking down after too many wrong entries, requiring admin approval, the number of which can be adjusted by the admin to be anything between one and 10. Combined with some excellent design and a solid metal case to store the drive, the DatAshur Pro 2 is the ultimate in portable data security. **–CG**

$179, http://istorage-uk.com/usa

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Compact Powerhouses
> Liquid Assets
> Airport Absence

Good-Looking Gaming

I've been a reader since *Boot #1* and your magazine has guided my builds and upgrades for a long, long time. My current system is an i7-3770K based system that I built back when that chip first launched, and it's housed in an even older Gigabyte Aurora 3D 570 case. With a GTX 970 video card and 16GB of RAM, it still handles *Overwatch* and *WoW* at 1920x1200 just fine. However, there's no escaping that it is old, and with games like *Cyberpunk 2077* and *MechWarrior 5* coming, I can see a new system sometime soon in my future.

I plan to go to a smaller form factor, and I'm not sure I want to build my next one. I got a bit excited last week when I saw the new Dell G5 Gaming Desktop and the Alienware Aurora R9. Both fall into my price range, promise user upgradeability, and aren't lit up like someone bought up all the Christmas lights at the dollar store. Any chance you are going to review one or both of them? In particular, I'm really curious to see if Dell has gone with industry standard form factors and connectors with these systems, or if the promised upgradeability is going to be limited because of a custom motherboard, power supply, or cooling solution. I'd really like to see you compare two similarly configured ones head to head, to see how Dell's Gaming PC stacks up and whether the Alienware is worth the premium, because they're essentially coming from two sides of the same manufacturer.

–Steve Latta

Alienware's Aurora R9 is a small but beautifully formed system.

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: It's refreshing to see a pair of new machines that look this good, even if they do originate from the same parent company. Predictably, it's the Alienware that will turn most heads, with the bold, diminutive design of the Aurora R9 making for a notable shift from previous bulkier machines, but the Dell G5 is certainly worth considering as well, with its more traditional case, looks, and lower price point. Both appear to offer reasonable value for money as well, although, as ever, the devil is in the details—the entry level builds aren't much of an upgrade from what you have already got, while a serious specification can hit $3K easily.

The Dell G5 Gaming Desktop is certainly an interesting proposition, and reminds us of simpler times when you could pick up a decent gaming machine without having to remortgage your house, or be forced to wear shades when actually using it. Still, you've spotted the classic problem with such machines, and in order to bring the price down to acceptable levels, non-standard motherboards tend to be the norm, especially from the big box shifters. Dell states that you can upgrade your CPU, GPU, memory, and hard drives in the G5, but the motherboard itself is a Dell branded unit, built around Intel's H370 Express chipset (which means there's no overclocking on offer), and that may not be so easy to replace. The Aurora R9, meanwhile, features a fairly low power PSU in the more affordable machines, which could limit your upgrade options later, and accessing the

↘ submit your questions to: comments@maximumpc.com motherboard in the R9 isn't straightforward either, although that does use a Z370 chipset.

We still favor building our own machines here, but can see the value in these. We'll try to get both machines in for review in a future issue, although it can take a while to get machines out of Dell, so don't hold your breath.

Vulgarity Check

When I received the August 2019 issue, I placed it face down on a table. It offends me to see (or hear) language like "Kick A**"—repeated in the title on page 24. Why inflict this vulgarity upon your readers? Can your talented writers not find language to convey their enthusiastic approval without resorting to the geeks' equivalent of "locker-room language"?

I have worked in three different IT environments. If I had used this language in my classroom, in the presence of my customers on a service call, or in my role as vendor to a major corporation, I am confident I would have been called out on it the first time it happened. The second time it happened would likely have been the last time for me in that environment.

Please think about whether using this language is needlessly offensive to readers for whom it is not "cool," but coarse. It detracts from the quality of your publication.

The phrase "Minimum BS" on the front cover might also be language to eliminate from the magazine. Thank you for your consideration.

–Walter O'Briant

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: *Maximum PC* has a long history—since its inception, in fact—of saying what it thinks and not pulling any punches. The best score a piece of hardware gets in our review section is the "Kick Ass" award, and we've had the "Minimum BS" on the cover since the beginning. In other words, it's part of the magazine's DNA, and isn't about to change. It's worth remembering, offense is taken, not given.

[NOW ONLINE]

BORDERLANDS 3 SPECS, SETTINGS, BENCHMARKS, AND PERFORMANCE

The latest tale from the Borderlands starts off easy on hardware, but you'll need to bring the big guns for higher resolutions. Early impressions of *Borderlands 3* suggest that, despite seven years (and a raft of rival loot shooters) having passed since *Borderlands 2,* Gearbox has stuck to its however-many-millions of guns. At its core, *Borderlands 3* is still about ganging up with a few friends, extinguishing a few thousand lives, and using the bodies as randomized loot vending machines.

What has changed is the tech. The jump from Unreal Engine 3 to UE4 has brought improved lighting, shadows, and effects to the signature hand-drawn style, and publisher 2K says the game was "developed from the ground up" to take advantage of AMD's most recent Radeon GPUs and third-gen Ryzens. As such, it supports AMD's FidelityFX suite, and goes without the DLSS and ray-tracing features offered by Nvidia RTX cards. Don't worry if you're on team GeForce, though: We've been testing the game across a range of GPUs and CPUs, and it looks like it will run decently on any hardware. Even the cheap stuff.

Read the full article: https://bit.ly/2m9gfzE

Dreams of Water

I am currently planning a new build and want some advice for a water cooler, as I have no experience with them. My build includes a Ryzen 7 3700X, a Gigabyte X570 Aorus Pro Wi-Fi motherboard, 16GB (2x 8GB) of G.Skill Trident Z RGB DDR4-3200 memory, a Corsair TXM Gold 550W (CP-9020133-NA) power supply, a 500GB Samsung 860 EVO SATA SSD, 1TB WD HDD, Asus DVD-E818AAT/BLK/B/GE optical drive, and a Rosewill RDCR-11004 data hub. What would you recommend for a water cooler? (I'd prefer around $100, but could go more.)

My second question is for a graphics card. I'd like to have a more powerful card (my current one is a GTX 960) and I wasn't sure if I should go for an RTX or for a GTX 1600 series. I don't do any heavy gaming, just a few games at 1080p and other moderate tasks.

–Gage Cross

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: That looks like a decent build that should last. One thing I would say is that you don't necessarily need an all-in-one water cooler for it, as we've been impressed by the coolers that ship with AMD's latest processors. Still, if you're set on adding water to the mix, the likes of the Corsair H100i have always served us well on our test bench.

When it comes to your graphics card, 1080p gaming isn't too demanding on the latest hardware, with the main question being whether you want to immerse yourself in real-time ray tracing or not. The likes of the Nvidia GeForce GTX 1660 is a reasonable upgrade from what you've got at the moment, but you're not going to be knocked out by it. Meanwhile, the most affordable RTX card, the GeForce RTX 2060 (non-Super) will set you back $320, and while the performance can be underwhelming at higher resolutions in the most demanding titles, you should be fine at 1080p.

Flight Risk

I like to purchase *Maximum PC* in airports. Recently, I've had trouble finding your magazine in airports such as JFK, LGA, ORD, and others. Are you having distribution problems?

–Sam Greenfield

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: I've spoken to our distribution department, and it transpires that the airports have increased the amount they charge to stock the magazine, to the point where we were losing money—it isn't worth selling through airports anymore. Can I suggest you take out a subscription, as that way you'll always have access to the magazine, no matter where you are?

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THE BUILDS

INGREDIENTS

PART			PRICE
Case	BitFenix Nova TG		$55
PSU	Corsair VS450 80+ White 450W		$50
Mobo	ASRock B450M R4.0 AM4		$70
CPU	AMD Ryzen 5 2600	**NEW**	$140
GPU	Gigabyte GeForce GTX 1660 OC 6GB	**NEW**	$230
RAM	8GB (2x 4GB) Team T-Force Vulcan Z @ 3,000MT/s		$42
SSD	120GB Crucial BX500 2.5-inch		$23
HDD	1TB Seagate Desktop ST1000DM003		$28
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit		$15

Approximate Price: $653

PRICES HAVE BEEN CLIMBING across the board this month, much to our frustration. Even the trusty Crucial BX500 cost us a few dollars more, although it refused to be unseated from its throne as the king of bargain-bin storage. Team Group's T-Force Vulcan Z memory also remained the best-value 8GB kit around. There wasn't much we wanted to change; rising GTX 1660 prices necessitated a quick switch over to a Gigabyte model of the GPU, although we were tempted by the similarly priced single-fan 1660 Phoenix from Asus. The main change this time around was downgrading back from the AMD Ryzen 5 2600X to the regular 2600, retaining the six-core model, but losing 0.2GHz of base clock speed. The 2600X had risen in price, though, and this shift enabled us to still make a small saving on the overall cost of this build, checking in at seven dollars cheaper than last issue.

INGREDIENTS

PART			PRICE
Case	Fractal Design Meshify C		$85
PSU	500W EVGA 500 BR 80+ Bronze	**NEW**	$50
Mobo	Gigabyte X570 UD	**NEW**	$160
CPU	AMD Ryzen 5 3600X		$240
Cooler	AMD Wraith Spire		N/A
GPU	Sapphire Radeon RX 5700 8GB		$350
RAM	16GB (2x 8GB) Team T-Force Delta RGB @ 3,200MT/s	**NEW**	$70
SSD	250GB Samsung 970 Evo Plus M.2 PCIe		$70
HDD	1TB Seagate Desktop ST1000DM003		$28
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $1,153

ONLY A MINOR SAVING on the mid-range build this time around, primarily found in a small price drop on the Ryzen 5 3600X. X570 motherboards have remained expensive, and while we're hoping for a price drop soon, we've had to switch to the Gigabyte X570 UD in the meantime to maintain our overall build price. Following that, we also switched up the memory, using Team Group's flashy T-Force Delta RGB to keep our price and performance the same while adding a little more pizazz to this rig. While we did explore other possibilities regarding the GPU, the fact remained that Sapphire's Radeon RX 5700 was still the best value card for this system. The last thing to be changed was the power supply; Cooler Master is out, and EVGA is in. The 500 BR PSU is functionally identical to the previous model, but costs five dollars less, making it an easy choice.

TURBO

UPGRADE OF THE MONTH

512GB SAMSUNG 970 PRO M.2 NVME SSD

Thanks to the arrival of PCIe Gen 4.0, slightly older Gen 3.0 M.2 drives are becoming more affordable, so now's a great time to pick one up if you haven't yet upgraded to a new X570 motherboard. The 970 Pro is an awesomely fast product, perfect for workstations or gaming PCs, with a maximum read speed of up to 3,500MB/s. With a nickel-coated heat spreader and a five-year limited warranty, there's very little to dislike about this drive. Even if you are rocking a Gen 4.0-compatible motherboard, this is still an excellent SSD. **$145, http://samsung.com**

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THERE WERE A FEW THINGS to tweak on our turbo build this month. A bit of evaluation determined that 360mm of radiator space was overkill for cooling the Threadripper 2950X, so we swapped it out for a 240mm AIO cooler from the same Fractal Design product line. Regarding the processor itself, we're taking an "if it ain't broke, don't fix it" approach and sticking with the 2950X. The X399 Phantom Gaming 6 from ASRock remains the best-value X399 motherboard on the market—close to a $100 less than the next model up—so there's no need to get rid of that either.

When we came to the GPU, we saw that last issue's "Upgrade of the Month" (the EVGA GeForce RTX 2070 Super Black) had risen in price, so we've gone for a more conservative option: the Zotac Gaming RTX 2070 Super. This twin-fan model is $20 cheaper than EVGA's card, and has nominally the same performance. We also swapped out the RAM to a slightly more affordable Sniper X kit from G.Skill, keeping the capacity and speed the same to ensure that this system doesn't experience a drop in performance.

Lastly, with the cash we saved, we decided to upgrade the SSD to a Samsung 970 Pro, netting us faster transfer speeds and 12GB of extra storage. PCIe Gen 3.0 M.2 drives have dropped significantly in price since the release of the new Gen 4.0 motherboards and SSDs, and we're very happy to take advantage of that fact.

For more of our component recommendations, visit www.pcgamer.com/hardware/buying-guides/

INGREDIENTS

PART			PRICE
Case	NZXT H700i		$189
PSU	850W Corsair TX-M Series 80+ Gold		$120
Mobo	ASRock X399 Phantom Gaming 6		$240
CPU	AMD Threadripper 2950X		$830
Cooler	Fractal Design Celsius S24 Blackout 240mm AIO	**NEW**	$115
GPU	Zotac Gaming GeForce RTX 2070 Super Twin Fan 8GB	**NEW**	$500
RAM	32GB (2x 16GB) G.Skill Sniper X @ 3,200MT/s	**NEW**	$145
SSD	512GB Samsung 970 Pro M.2 NVMe	**NEW**	$145
HDD	2x 3TB Seagate BarraCuda Compute		$160
OS	Windows 10 Home 64-bit OEM		$100
Approximate Price:			**$2,544**

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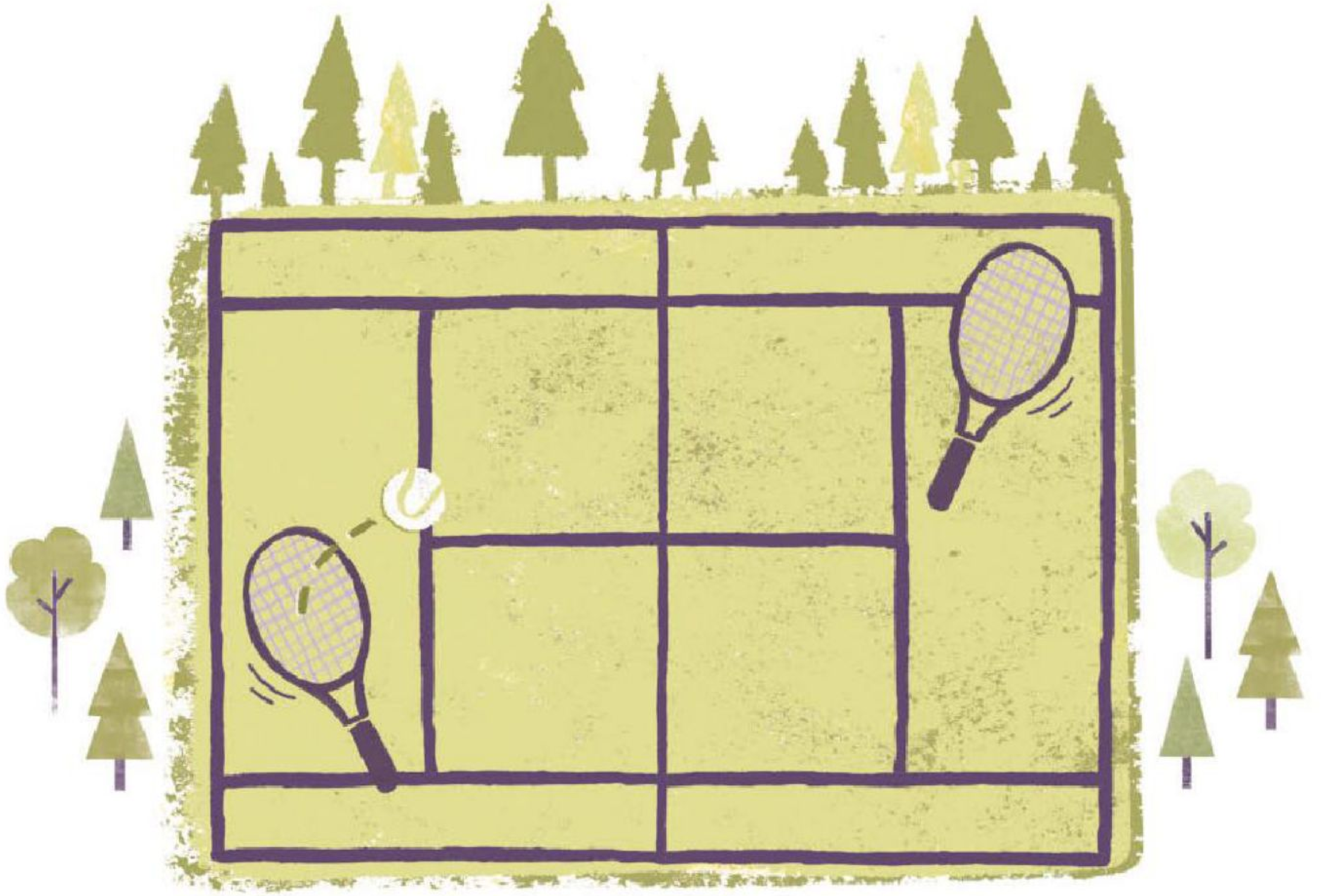

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UNFAO, Global Forest Resources Assessment 2005-2015

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